# INDUSTRIAL ENGINEER

*Devoted to the Maintenance and Operation of Electrical and Associated Mechanical Systems in Mills and Factories*

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# From the Viewpoint of Protection

## *Can You Beat This Job?*

PROTECTION in a mill or factory in connection with machines and electrical circuits has a two-way interpretation. (1) Safeguarding the machine from destruction through uncontrollable failure of some part of it—in the case of a motor protection through control against overloads, short circuits and the like. (2) Safeguarding life and limb of machine operators and providing a factor of safety against thoughtlessness, carelessness and the failing of human nature to take chances and flirt with known dangers. Perhaps I might add a third essential, or attach it to the first one; namely, protection against makeshifts and sloppy workmanship by setting up ship-shape standards of installation and following them closely.

I have mentioned safeguarding machines from uncontrollable accident and destruction first because this is a widely recognized necessity from the standpoint of the possible loss and expenditure of new capital that such safeguarding prevents.

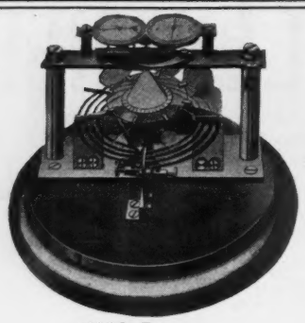
Safeguarding life and limb comes first in importance, however, from both financial loss to the management and from the latter's obligation to the human family. Experience and intelligent craftsmanship that represents engineering thinking on the part of workers who make it possible to operate machines at their greatest capacity in the manufacture of any and every product is the greatest asset that a mill or factory management possesses. And the failure to recognize the dollars and cents it costs to train up to these high standards of ability on the part of management and the failure of craftsmen to appreciate such training and the opportunity for its application under adequate protection, are points that are most misunderstood between capital and labor at this very minute. Therefore, protection against accidents to workers and an understanding on their part that their welfare and safety is of prime consideration in the environment in which they work makes one plant more attractive to high grade ability than another where the same scales of wages are paid.

In the accompanying illustration there are some points worth mentioning: No exposed live circuits; accessibility for inspection confined to authorized persons; good sized boxes for making circuit changes and pulling in new wiring; substantial mounting close to wall and a fair degree of ship-shapeness about the general workmanship of the job.

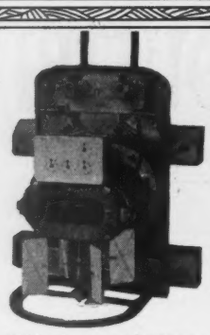
If you were to install this equipment perhaps you could improve on it. If you think you have done so already, send a photo and tell us about it.

Practical Pete

1880 - EDISON
Chemical ampere-hour meter



1886 - FORBES



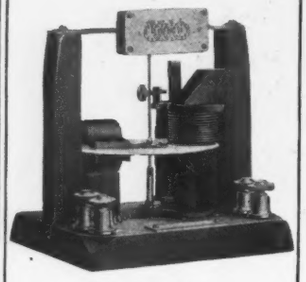
1888 - SHALLENBERGER
First induction-type meter (ampere-hr)

1889 - ELIHU THOMPSON
Motor type (Watt-hour)

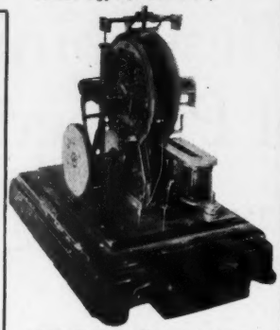
# Integrating Meters

## *Their Invention and Development*

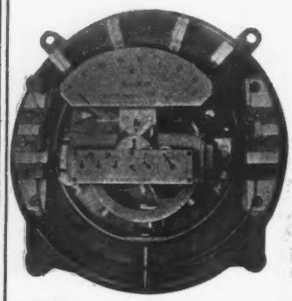
TO American inventors the greatest share of credit for developing integrating meters is due. The first American meter and the simplest was made by Gardiner in 1872. It consisted of a dial train driven by clockwork as long as an electromagnet in series with the line was energized. It took no account of the value of current or voltage. Nor did the first alternating-current meter, invented in 1878 by Fuller. This meter used an electromagnet with a polarized armature whose vibrations were recorded by a ratchet and dial. In 1881 Ayrton and Perry made a meter with two clock-driven pendulums, one acted upon also by an electromagnet. This type was later developed with some success by Aron. A meter made by Forbes in 1886 consisted of light vanes which were turned by heated air arising from conductors carrying current. To take account of varying current in a line, Edison from 1878 to 1881 perfected a chemical meter, in which the current deposited proportional amounts of metal from an electrolyte on metal plates. In 1881 Edison also devised the first motor type of meter. In 1888 Shallenberger developed the alternating-current induction-type meter. Elihu Thompson in 1889 built the first meter which recorded watt-hours instead of ampere-hours. This was a motor type of meter without iron in the armature. To overcome friction on light load an auxiliary shunt coil was employed. Shallenberger soon after arranged his meter to record watt-hours. These two types with modifications have been made in great numbers and are in wide use today. Among improvements in the induction-type meter was the use, by Duncan in 1892, of a single aluminum disk for driving and retarding and the no-load compensation by distorting the shunt field applied in 1895. In 1905 the mercury watt-hour meter was perfected by the Sangamo Electric Company.



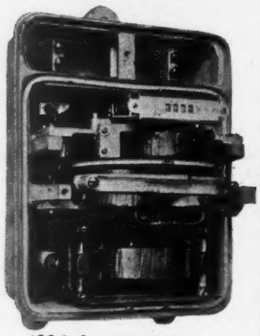
1892 - DUNCAN
(Watt - hour)



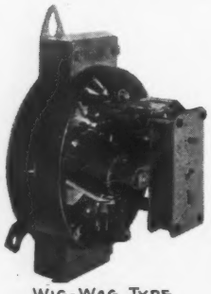
1893 - PENTZ - RECKENZAUM
Two-pendulum type



1893 - SIEMENS AND HALSKE
Circular Oscillating Pendulum

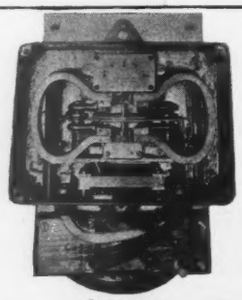


1894 - SHALLENBERGER
(Watt - hour)

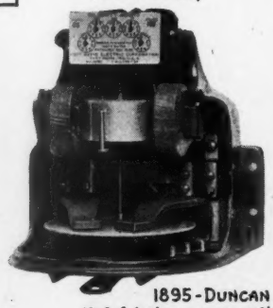


WIG-WAG TYPE
(Ampere - hour)

VIBRATING TYPE

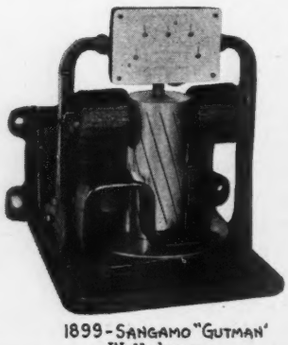


STANLEY
Magnetic suspension of disk

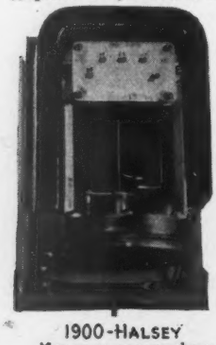


1895 - DUNCAN
Had friction compensation

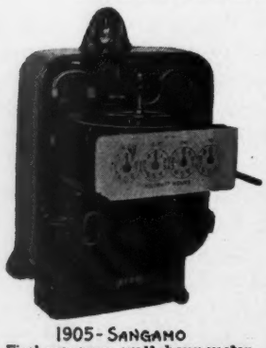
1897 - HARRIS
Clock-driven, governor-controlled



1899 - SANGAMO "GUTMAN"
Watt-hour



1900 - HALSEY
Mercury ampere-hour



1905 - SANGAMO
First mercury watt-hour meter

*Reserve motors are stored in steel cabinets like those at the left. Records of the Maintenance Department are filed in cabinets such as shown in the illustration above.*

## *Procedure When Handling Equipment Changes and*

# Maintenance of Electrical And Associated Mechanical Systems

## *Together With the Purchasing and Stockkeeping Routine for the Departments of a Large Works*

By L. J. STEWART

*Auditor, Western Clock Company, La Salle, Ill.*

IN THE purchase and stocking of new equipment and the parts and supplies used in maintenance work, the routine followed at the works of the Western Clock Company, La Salle, Ill., is the result of much careful thinking and planning by all the departments concerned. It involves close control of purchasing while providing that important decisions shall be made by those who are best qualified by training and experience. The maximum protection is thus afforded against costly errors due to carelessness or poor judgment. Confusion and loss in the stockroom are avoided by strictly segregating the supplies used by the maintenance department from the raw materials used in production.

As shown by the organization chart (Fig. 1), the work of the maintenance department is varied in character and is divided into five main branches: Installation and maintenance of electrical equipment; millwright work; plumbing work; carpenter work; janitor and watchman service.

**In a large industrial works such as that of the Western Clock Company, covering about twelve acres and divided into thirty-eight departments, producing many thousands of clocks and watches a day, well known as the Big Ben, Sleep-Meter, America, Pocket Ben and others, an adequate system for handling changes in equipment and maintenance is essential.**

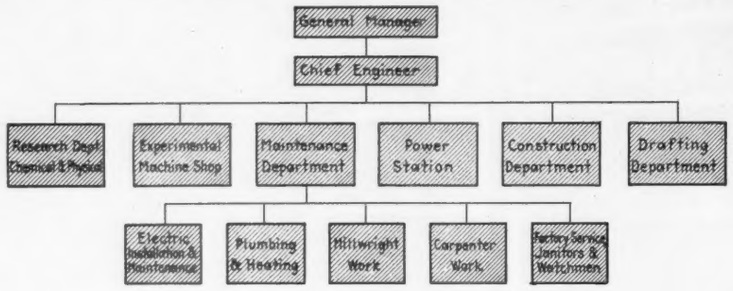
**The methods described in this article include the purchasing and storekeeping routine for a wide variety of equipment and supplies. The maintenance department is responsible for the continuity of production and handles all the work on electrical and associated mechanical systems.**

Twelve men are required in the electrical division to handle the installation, maintenance and repair of the electrical equipment, comprising the power, lighting, fire alarm, time clock and telephone systems. The work of the millwright division, which employs four men, is about equally divided as follows: Installation and repair of belts and shafting; moving machinery and heavy equipment; making and installing safety guards for machines; making metal racks, bins and so on. Four men are also employed in the plumb-

ing division, to take care of new and repair work on the water, air, gas, high and low pressure steam lines and the sprinkler system. Five carpenters are kept busy on building alterations and repair work, making wooden benches, boxes and similar equipment and repairing desks, chairs and other office furniture, while two painters are required to do the necessary painting and glazing.

A correspondingly wide variety of supplies is used in carrying on these varied activities, and the head of the *Maintenance Department* is charged with the responsibility of selecting the materials and equipment to be purchased. His decisions are based on the results obtained in service and on special trials and tests. In addition, conferences are frequently held with salesmen and engineers of the makers of the equipment that comes under his jurisdiction. The same procedure is followed by the other departments. For example, if a machine is to be purchased, the *Manufacturing Department* will decide on the make and type best suited for the production requirements. The *Purchasing Department* functions as the point of outside contact in the placing of orders, the analysis of prices, terms, delivery and the like. All orders of any nature pass through and are placed by the *Purchasing Department.*

**Fig. 1.—Co-ordination in the Execution of Engineering, Operating and Maintenance Work**




Carefully prepared reports and record forms are used in the purchase and utilization of equipment and supplies. An example will serve to show the routine that is followed. The *Manufacturing Department* decided, after investigation, that a certain machine should be changed from belt drive to individual motor drive. The first step in the process of putting this change into effect was to fill out in duplicate the *Change Recommendation* form shown in Fig. 2, and send the original copy to the superintendent. The carbon copy was retained by the *Manufac-*

Change Recommendation. 6952

Mr. Superintendent:

It is recommended that machine No. 22045 be equipped with motor drive. This machine is operated only about half of the time and motor drive will allow it to be stopped when not in use. It will also permit the machine to be placed to better advantage.

Date 3/1/22 Signed Foreman

Referred to Engineering Department. Notified 3/1/22

Date _____ Approved Supt.

Investigation of Proposed Changes.

To Equip Machine No. 22045 with motor drive.

Mr. Chief Engineer:

Kindly investigate the advisability of making the above change.

Date 3/1/22 Signed Supt.

Report

Mr. Superintendent:

The Engineering Department finds that motor drive for machine No. 22045 will be advantageous.

Date 3/4/22 Signed Chief Engineer

**Fig. 2—This is the starting point for changes of old equipment or the purchase of new equipment.**

The proposed changes and reasons therefor are given in the form at the left and sent to the superintendent. If he wishes to get the opinion of other departments before making a decision the form at the right is filled out and sent to the heads of these departments. Record of such action is made on the Change form. After the Investigation forms are returned with the recommendations, the superintendent's decision is noted on the Change form.

**Fig. 3—Order form for work to be done by the Maintenance Department.**

With the exception of certain routine jobs with permanent job numbers (see page 321), no work will be done by the Maintenance Department without this order approved by the superintendent. The head of the Maintenance Department assigns the job number, and in this case specified the size of motor. After initialing the order in the lower left-hand corner, the original is sent to the foreman of the division which will do the work and the copy is filed. When the job is completed the foreman returns the original, which is filed and the copy is destroyed.

**Maintenance Order Blank**

Westclox

To Engineering Division Job No. 78142

From Manufacturing Dept. Date 3/6/22

Description of work—

Install motor drive on machine No. 22045.

5 hp. type RC Western Electric

Signed Foreman (Maker)

Signed W.B.J. (Engineering Division) Approved Supt.

**Fig. 4—Orders for the installation of equipment must be made on this form.**

This installation order is made in duplicate, both copies are attached to the third (pink) sheet of the purchase requisition, Fig. 6, and go to the storekeeper, who keeps them until the equipment is received. The original is then sent to the Auditing Department and the second (yellow) sheet goes to the Maintenance Department.

## Installation of Property Order

Factory No. 20957 Date 3/6/22 192

Description 5 hp. Western Electric motor

Please install the above mentioned Property by as soon as possible 192

To be placed on machine No. 22045, Manufacturing Dept.

Article to be moved from Dept. Bldg. to Dept. Bldg.

To be moved by Maintenance Dept.

Safety device put on by Approved Committee

Article Numbered by Maintenance Dept. 3/17 192 2

Approved Supt. (Factory Supt.)

Installed in Manufacturing Dept. 3/17 192 2 Signed Foreman. (Foreman)

*No property Installed without this oder. When order is completed return to Acct. Dept.*

*turing Department.* This form is made out, the original going to the superintendent and the carbon copy being retained by the department which originates the form, whenever changes are proposed which involve alterations or changes in location of old equipment or the purchase of new equipment. If the amount of money involved is small, or the superintendent feels that the proposed change is warranted and does not require investigation on his part, he will approve the recommendation and issue the orders, referred to later on, that are needed to put this change into effect.

In the present instance it was thought advisable to obtain the opinion of the *Engineering Department*, and so an *Investigation of Proposed Changes* form, Fig. 2, was made out in duplicate and sent to the chief engineer. If opinions are also desired from other departments, extra copies of the form are made and sent to them. For example, changes or purchases of equipment which involve a large expenditure of money are frequently referred to the *Auditing Department*, with a request for an opinion as to whether the proposed action is advisable when considered from the standpoint of an investment. Authority to make unusual expenditures is obtained from the general manager, who in turn may lay the matter before the board of directors.

On the basis of the reports turned in, the superintendent decides whether the proposed change shall be made. In the case described here, the *Engineering Department* decided that a change from belt to motor drive was advisable. (See lower portion of form at right, Fig. 2.)

The superintendent accordingly approved the change and issued *Maintenance Order Blank*, Fig. 3, and *Installation of Property Order*, Fig. 4, leaving the second line of the latter (Description) blank, to be filled in later by the *Maintenance Department* after the size and type of motor to be used had been determined. The order, Fig. 3, authorizing the *Maintenance Department* to do the work is made out in duplicate. Upon its receipt the head of the department signs it in the lower

## Maintenance Orders Index

FINISHED FINISHED

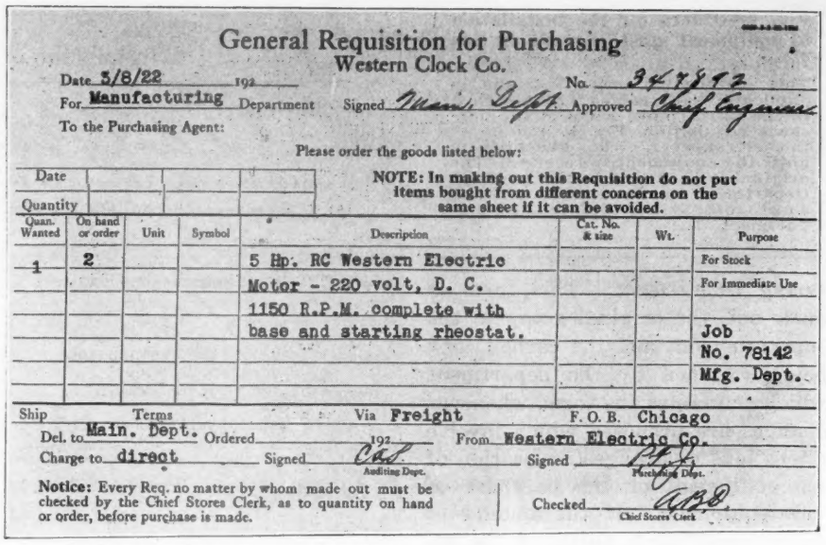
| Number | Description | Department | Received | Finished | By |
|---|---|---|---|---|---|
| | | | | | |
| 71050 | Repair faucets | Toilet #1 | 10/27/20 | 11/12/20 | |
| 71051 | " radiator | Bld'g 15 | 10/27/20 | 11/6/20 | |
| 71052 | " flusher toilet #9 | Toilet #3 | 10/27/20 | 11/6/20 | |
| 71053 | " two toilets and faucet | Bld'g 15 | 10/27/20 | 11/6/20 | |
| 71054 | Radiator leaks in restaurant | " " | 10/27/20 | 11/6/20 | |
| 71055 | Air cock on radiator | Bureau of Stands | 10/27/20 | 12/11/20 | |
| 71056 | Light over station | Time keeping | 10/27/20 | 11/16/20 | |
| 71060 | Starting box | Power Press | 10/27/20 | 10/28/20 | |
| 71061 | Swinging doors | Store Dept | 10/27/20 | No date | |
| 71062 | Install gas burners | Auto Casting | 10/27/20 | 10/27/20 | |
| 71063 | Build pattern | Engineering | 10/28/20 | 10/28/20 | |
| 71064 | Plug for pipe | " | 10/28/20 | 10/28/20 | |
| 71065 | Replace fuse | Spring Coiling | 10/27/20 | 10/27/20 | |
| 71066 | Repair lights | Shipping | 10/27/20 | 10/30/20 | |
| | | | | | |
| 71067 | Light socket | 2" Material | 10/27/20 | 10/27/20 | |
| 71068 | Connect motors etc. | Automatic Casting | 10/27/20 | 10/27/20 | |
| 71069 | Install card records | Time Keeping | 10/27/20 | No date | |
| 71070 | Replace window panes | Chem. Lab. | 10/28/20 | 10/28/20 | |
| 71071 | Wire of motor #2036 | Power Press | 10/27/20 | 10/27/20 | |
| 71072 | Repair roof | Auto Casting | 10/27/20 | No date | |
| 71073 | " window | Vibrating | 10/28/20 | 11/1/20 | |
| 71074 | Replace fuse | Wheel Cleaning | 10/28/20 | 10/29/20 | |
| 71075 | Install adding machine | Sales Dept. | 10/28/20 | 10/29/20 | |
| 71076 | " safety device | Power Press | 10/28/20 | 10/29/20 | |
| 71077 | " cabinets | Traffic | 10/28/20 | 10/8/20 | |
| 71078 | Build cabinet - personal - L.J. Stewart | | 10/28/20 | 10/29/20 | |
| 71079 | Hardwood block | Tool Dept | 10/28/20 | No date | |
| 71080 | New caster for chair | Auditing | 10/28/20 | 10/29/20 | |
| | | | | | |
| 71081 | Repair furnace | Spring Coiling | 10/28/20 | 10/28/20 | |
| 71082 | Place lights on machines | Training | 10/27/20 | 10/29/20 | |
| 71083 | Place shelves in Lab | Phy. Test | 10/28/20 | 11/6/20 | |
| 71084 | Two pinions | Engine Room | 10/28/20 | 10/29/20 | |

**Fig. 5—The Maintenance Department keeps track of its orders on sheets like this.**

As soon as an order is received it is given a serial job number and entered on these sheets, which are filed in a loose-leaf ledger. When a job is finished the date is placed opposite the date of the order. When one sheet is full, all unfinished jobs are carried forward as a check on the work of the department.

**Fig. 6—The Purchasing Department buys equipment in accordance with this requisition.**

When the Maintenance or other department decides on the make and type of equipment to be used, this requisition is issued in quadruplicate and all copies are first sent to the Purchasing Department. The original (white) is attached to the white copy of the Purchase Order, Fig. 7 and filed in the Purchasing Department; the second (yellow) sheet is sent to the Auditing Department; the storekeeper gets the third (pink) sheet, attached to both copies of the installation order, Fig. 4, so that he will know what equipment is coming and where it is to be used, and the fourth (blue) sheet is returned after the required approval, to the maker of the requisition.



General Requisition for Purchasing
Western Clock Co.

Date 5/8/22 192 No. 347992
For Manufacturing Department Signed Main. Dept. Approved Chief Engineer
To the Purchasing Agent:
Please order the goods listed below:

Date
Quantity

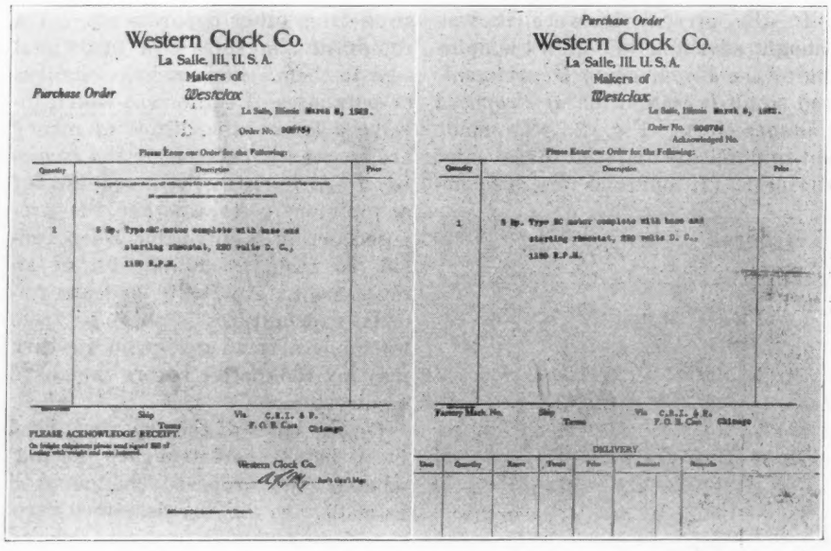
NOTE: In making out this Requisition do not put items bought from different concerns on the same sheet if it can be avoided.

| Quan. Wanted | On hand or order | Unit | Symbol | Description | Cat. No. & size | Wt. | Purpose |
|---|---|---|---|---|---|---|---|
| 1 | 2 | | | 5 Hp. RC Western Electric | | | For Stock |
| | | | | Motor - 220 volt, D. C. | | | For Immediate Use |
| | | | | 1150 R.P.M. complete with | | | |
| | | | | base and starting rheostat. | | | Job |
| | | | | | | | No. 78142 |
| | | | | | | | Mfg. Dept. |

Ship Terms Via Freight F. O. B. Chicago
Del. to Main. Dept. Ordered 192 From Western Electric Co.
Charge to direct Signed C.A.S. (Auditing Dept.) Signed P.P.J. (Purchasing Dept.)
Notice: Every Req. no matter by whom made out must be checked by the Chief Stores Clerk, as to quantity on hand or order, before purchase is made. Checked A.B.B. (Chief Stores Clerk)

left-hand corner and sends the original to the foreman of the division by which the work requested will be done. In this case it went to the electrical division. The duplicate of the order is filed in the *Maintenance Department*. When the work is complete the division foreman turns in the original, which is then filed, while the duplicate is destroyed.

This order was also entered, in accordance with routine, on the *Maintenance Orders Index*, shown in Fig. 5 and given a number. These sheets are filed in a loose-leaf ledger and, as will be noted, give a description of the work required, the department making the request and the date the order was received. The date on which the work was completed is entered opposite the receiving date. When a new sheet is started all unfinished jobs are carried over, so that the head of the *Maintenance Department* can tell in a moment how many unfinished jobs are on hand and how long they have been running.



Western Clock Co.
La Salle, Ill. U. S. A.
Makers of
Westclox
Purchase Order
Please Enter our Order for the Following:
Quantity | Description | Price
1 5 Hp. Type RC motor complete with base and starting rheostat, 220 volts D. C., 1150 R.P.M.
Ship Via C.R.I. & P.
Terms F. O. B. Cars Chicago
PLEASE ACKNOWLEDGE RECEIPT.
Western Clock Co.

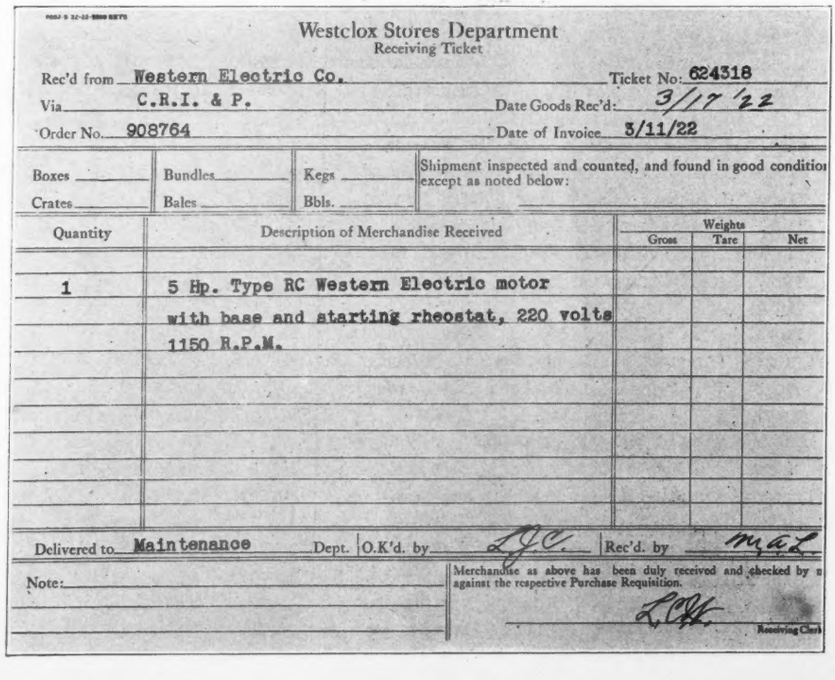
Purchase Order
Western Clock Co.
La Salle, Ill. U. S. A.
Makers of
Westclox
Order No. 908764
Acknowledged No.
Please Enter our Order for the Following:
Quantity | Description | Price
1 5 Hp. Type RC motor complete with base and starting rheostat, 220 volts D. C., 1150 R.P.M.
Factory Mach. No. Ship Via C.R.I. & P.
Terms F. O. B. Cars Chicago
DELIVERY
Date | Quantity | Route | Train | Pcks | Amount | Remarks

**Fig. 7—Order form for the purchase of equipment and supplies.**

This form is made out in quadruplicate. The first sheet, at left, is sent to the maker of the equipment. The second (white) sheet, right, is attached to the original (white) sheet of the purchase requisition, Fig. 6 and filed. The third (pink) sheet is attached to both copies of the installation order, Fig. 4, and to the pink copy of the purchase requisition and sent to the storekeeper. The fourth (yellow) sheet goes to the Stores Accounting Department.

**Fig. 8—A record of the material delivered is made on this receiving ticket.**

Upon receipt of the invoice, the Stores Accounting Department notes the kind and quantity of material expected. This ticket is made in triplicate and all three copies are first sent to the storekeeper. When the material is received, the storekeeper checks it as to quantity, kind and condition, and after recording the data called for, sends the white original to the Purchasing Department, where it is filed with the copy of the Purchase Order; the second (pink) sheet is filed by the storekeeper, while the third (yellow) sheet is attached in the Stores Accounting Department to the invoice and sent to the Auditing Department.



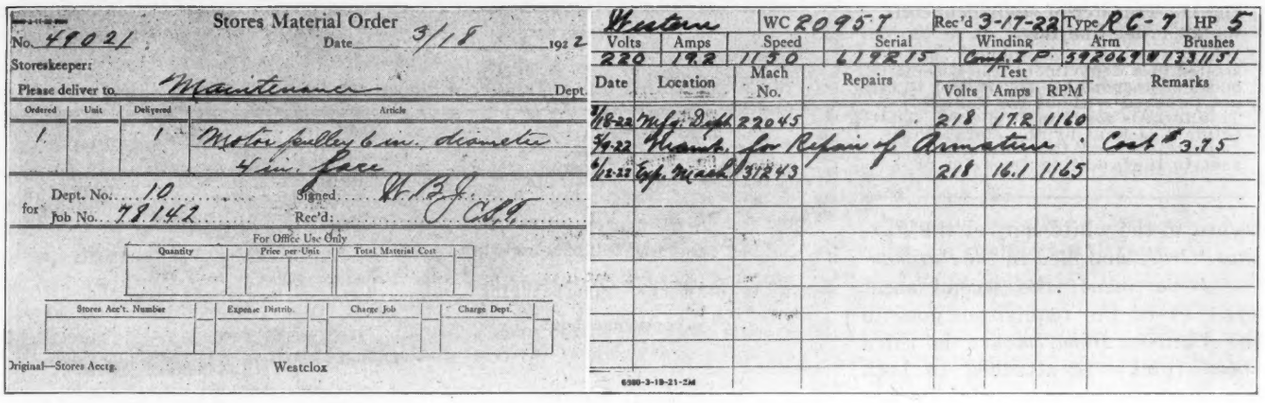
Westclox Stores Department
Receiving Ticket

Rec'd from Western Electric Co. Ticket No: 624318
Via C.R.I. & P. Date Goods Rec'd: 3/17/22
Order No. 908764 Date of Invoice 3/11/22

Boxes | Bundles | Kegs | Shipment inspected and counted, and found in good condition except as noted below:
Crates | Bales | Bbls.

| Quantity | Description of Merchandise Received | Weights Gross | Tare | Net |
|---|---|---|---|---|
| 1 | 5 Hp. Type RC Western Electric motor with base and starting rheostat, 220 volts 1150 R.P.M. | | | |

Delivered to Maintenance Dept. O.K'd. by L.J.C. Rec'd. by M.A.L.
Note:
Merchandise as above has been duly received and checked by us against the respective Purchase Requisition.
L.C.K. (Receiving Clerk)



Stores Material Order

No. 49021 Date 3/18 192 2

Storeskeeper:

Please deliver to Maintenance Dept.

| Ordered | Unit | Delivered | Article |
|---|---|---|---|
| 1. | | 1 | Motor pulley 6 in. diameter 4 in. face |

for Dept. No. 10 Signed W. B. J. C. & P.

Job No. 78142 Rec'd:

For Office Use Only

| Quantity | Price per Unit | Total Material Cost |
|---|---|---|
| | | |

| Stores Acc't. Number | Expense Distrib. | Charge Job | Charge Dept. |
|---|---|---|---|
| | | | |

Original—Stores Accts. Westclox

Westom WC 20957 Rec'd 3-17-22 Type RC-7 HP 5

| Volts | Amps | Speed | Serial | Winding | Arm | Brushes |
|---|---|---|---|---|---|---|
| 220 | 192 | 1150 | 619215 | Comp. 2 P. | 592069 | 133 1151 |

| Date | Location | Mach No. | Repairs | Test Volts | Test Amps | Test RPM | Remarks |
|---|---|---|---|---|---|---|---|
| 4/8-22 | Mfg. Dept. | 22045 | | 218 | 17.2 | 1160 | |
| 4-22 | Maint. for Repair of Armature | | | | | | Cost $3.75 |
| 4/2-23 | Exp. Mach. | 31243 | | 218 | 16.1 | 1165 | |

6300-3-19-21-2M

**Fig. 9—Stores material order and motor record card.**

When the Maintenance or other department wishes to draw material from the storeroom the form at the left is made out in triplicate. The original is sent to the Stores Accounting Department, while the second copy is filed in the storeroom and the third goes back to the maker. The Maintenance Department keeps a card like the one at the right for every motor in the factory. When a motor is first installed or its location changed, the data shown is recorded, and also the repairs which may be required from time to time. A complete history of the motor is thus available at a glance.

In general, no work will be done by the *Maintenance Department* without this properly signed *Maintenance Order Blank*, so that these, taken together, constitute a complete record of all work done. This form is used for all work orders drawn on the *Maintenance Department*. In emergencies, such as trouble with motors, fuses or lights, the foreman of the department affected may telephone the *Maintenance Department* and ask that the necessary repairs be made and this verbal order will be accepted, but it must be followed as soon as possible by a written, confirming order.

An exception to the above rule is made in the case of certain routine jobs, to which permanent job numbers have been assigned, and therefore do not require an order each time the work is done. These jobs are as follows:

| Routine Work | Job Number |
|---|---|
| Plating rack repairs | 700 |
| Supplying steam for restaurant | 701 |
| Oiling line shaft, etc | 702 |
| Inspecting fire equipment | 703 |
| Oiling and inspecting motors | 704 |
| Inspecting time clocks | 705 |
| Lighting gas | 706 |
| Starting and stopping motors | 707 |
| Heating plating room tanks | 708 |
| Collecting gasoline | 709 |
| Inspecting concrete tank | 710 |
| General supervision | 711 |
| Miscellaneous work on patterns | 712 |
| Charging batteries | 713 |
| Cleaning and oiling buff lathes | 714 |
| Tramrail | 715 |

The installation order, Fig. 4, is also made out on a white original and a yellow duplicate. When the head of the *Maintenance Department* decides on the size, type and so on of equipment (motor in this case) best suited for the service to be rendered, he fills in the second line (Description) and makes out a *General Requisition for Purchasing*, Fig. 6. This is made in quadruplicate and all of the copies go first to the *Purchasing Department*. The *Purchasing Department* then makes out a *Purchase Order*, Fig. 7, also in quadruplicate, and sends the original to the maker of the equipment or material desired. The original (white) of this purchase requisition is at-

RECORD NUMBER 21536

DESCRIPTION #00-C Auto. Screw Machine.

DATE PURCHASED 12-8-20

INVOICE NO. 610

MAKER Brown & Sharp Mfg. Co.

MAKERS NO. 5764

PURCHASED FROM " " " "

EQUIPMENT OTHER INFORMATION

| | |
|---|---|
| PURCHASE VALUE | 1325.00 |
| FREIGHT | 28.00 |
| CARTAGE | 2.50 |
| INSTALLATION | 7.50 |
| | 1363.00 |

| DATE | IMPROVEMENTS | |
|---|---|---|
| 1-7-22 | Screw Slotting Attachment | 90.00 |
| | | 1453.00 |

DEPR. RATE PER YR.

DEPR. PER YR.

DATE FULLY DEPR.

| LOCATION DEPT | LOCATION BUILDING | REPAIRS DATE | AMOUNT | DATE | AMOUNT | DATE | AMOUNT |
|---|---|---|---|---|---|---|---|
| 3-26-21-17 | 6 | 10-1-21 | 6.50 | Feed Tube. | | | |
| 3-23-22-16 | 7 | 2-6-22 | 2.40 | Pulley. | | | |

**Fig. 10—Here is a good way of recording valuable information about equipment.**

As soon as any piece of plant equipment is received it is given a number and entered on a card like this, which is kept in the Auditing Department files. The location, together with the cost of all improvements and repairs, is noted, so that, knowing the depreciation, the present value and almost any other information required can easily be found.

**Fig. 11—Transfer of equipment calls for an order like this.**

When a piece of equipment is installed in a department, the foreman becomes responsible for it and it is not removed without his knowledge. This form is made in duplicate. The original is kept by the Maintenance Department and the yellow copy is sent to the Auditing Department.

Transfer of Property Order

Factory No. 20957 Date 6/10/22 192

Description 5 Hp. Western Electric motor, 1150 R.P.M.

Released by Mfg. Dept. Signed C.H.R. Foreman. Date 6/11/22

To be placed in Experimental Machine Shop by at once 192

Article to be moved from Dept. Manufacturing Bldg. 8 to Dept. Exp. Mch. Bldg. 7

To be moved by Maintenance Dept. Approved Factory Supt.

Safety Device put on by Approved Committee

Received in Experimental Machine Dept. Signed F.E.G. Foreman. Date 6/11/22

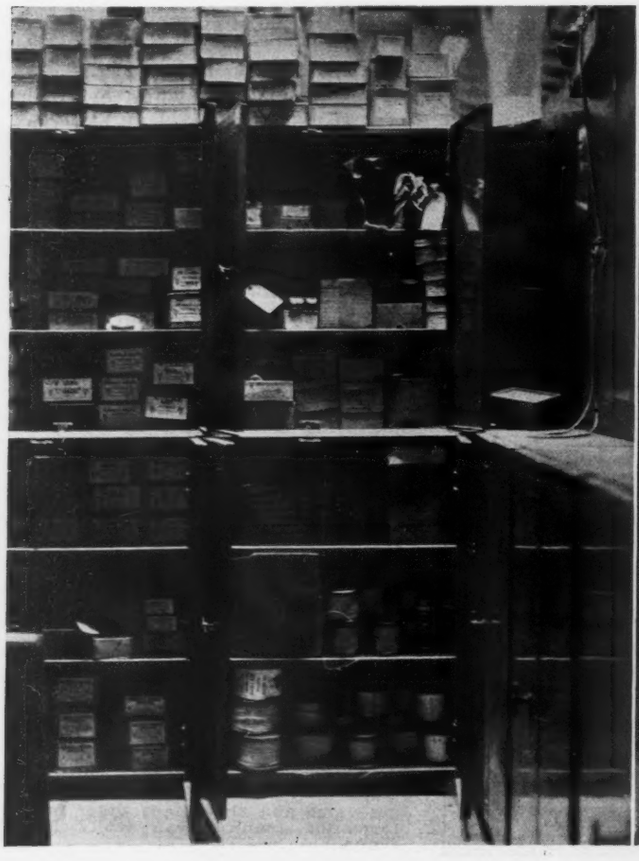
*No Property Moved without this Order. When Order is Completed Return to Acct. Dept.*

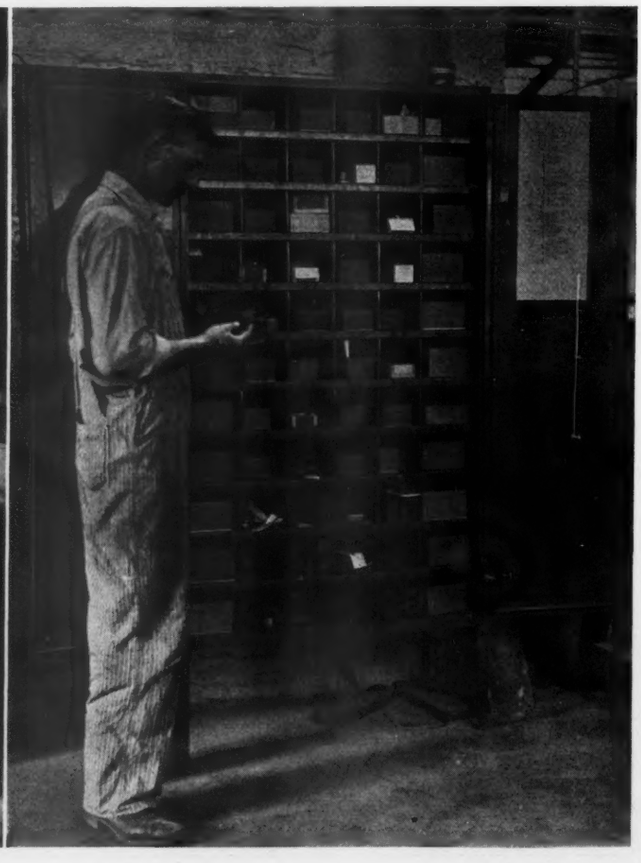
tached to the white copy of the *Purchase Order* and filed in the *Purchasing Department;* the second sheet (yellow) of the requisition goes to the *Auditing Department;* the third sheet (pink) is attached to both copies of the installation order and to the pink copy of the *Purchase Order* and sent to the storekeeper, so that he will know what equipment is expected and what to do with it. The fourth (yellow) sheet of the order is sent to the *Stores Accounting Department.* The fourth sheet (blue) of the purchase requisition is returned for filing to the maker (*Maintenance Department*) with the purchasing agent's signature, as evidence that the order has been duly placed.

When the invoice covering the motor is received, the *Stores Accounting Department* makes out a *Receiving Ticket,* Fig. 8, in triplicate, describing the kind and quantity of equipment, and sends all three copies to the storekeeper. When the motor comes in, the storekeeper checks it against his pink copy of the requisition, signs the ticket and sends the original (white) sheet to the *Purchasing Department,* where it is filed with the copy of the purchase order. The second (pink) sheet is retained by the storekeeper, while the third (yellow) sheet goes to the *Stores Accounting Department,* where the invoice is attached to it and both are then sent to the *Auditing Department.* The storekeeper also records the receipt of the motor in a ledger which is kept in the

**Fig. 12—The Maintenance Department keeps its supplies in steel cabinets.**

Cabinets like those at the left are used for storing all of the miscellaneous supplies. These cabinets are approximately 6 ft. high and 2½ ft. wide. The upper half is 1 ft. deep while the lower is 2 ft. deep. The top of the lower portion thus forms a handy ledge or shelf. The cabinet at the right is divided into 66 compartments and contains the stock of brushes of various sizes which are used on the motors and generators in the works. The sheet pasted on the door gives the size and make of motor on which the brushes in each compartment are to be used. This cabinet is provided with a lock and for the sake of convenience is kept in the motor repair shop, instead of in the storeroom where all of the other supplies for the Maintenance Department are kept.





storeroom and used only for motors and special equipment.

Upon notification from the storekeeper, who sends in the *Installation of Property Order*, that the motor has been delivered, the *Maintenance Department* proceeds to install it in accordance with the order, Fig. 3, directing it to do this work. Since supplies, wire, conduit, belting and so on are required for installation, the form at the left in Fig. 9 is filled out in triplicate and presented to the storekeeper. The original goes to the *Stores Accounting Department*. The storekeeper retains the second copy for his file and returns the third copy to the *Maintenance Department* to be held as their record. This triplicate form is employed in drawing from the storeroom all material used by the *Maintenance Department* in installation or repair work.

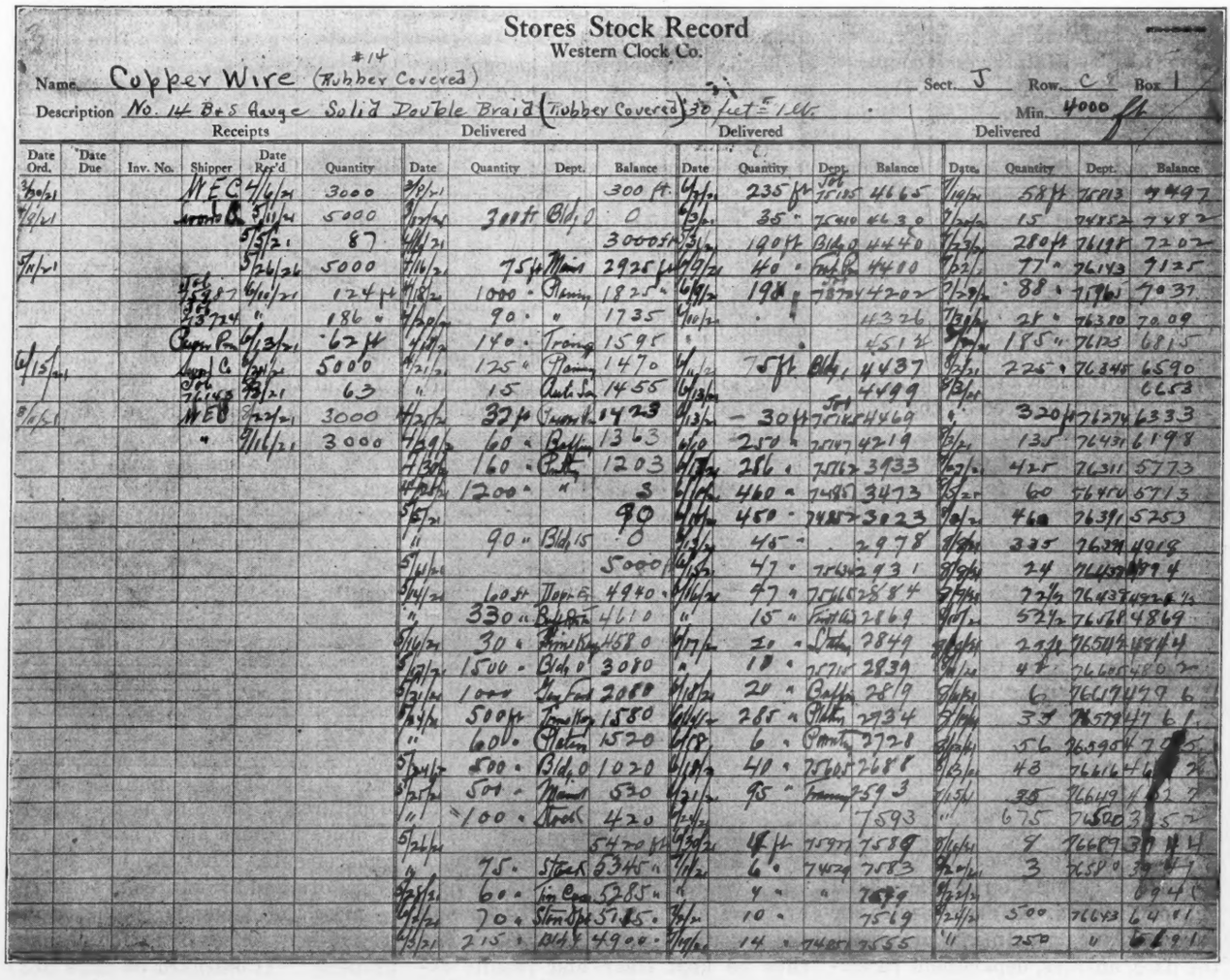
Requisitions which are made by the foremen of other departments for material carried in this storeroom are honored, except when they call for lamp bulbs. Such requisitions must be approved by the head of the *Maintenance Department*. This is done in order to prevent the use of lamps which are larger than the *Maintenance Department* considers necessary.

When the motor is installed, the *Maintenance Department* determines the speed, current and voltage and enters these, together with the nameplate data, serial and factory numbers, date installed, location and so on, on a 3-in. by 5-in. card, shown at right, Fig. 9, in a file kept in that department. This file contains a card for every motor in the factory. Whenever changes in location or repairs are made on a motor they are noted on the motor card, so that from the latter the full history of the motor, in so far as the *Maintenance Department* is concerned, can be quickly found. The cards are filed in groups according to the size of the motor; that is, the cards for all ½-hp. motors are filed together, and so on for each size.

A *Property Inventory Card*, Fig. 10, which is similar but larger and contains more detailed information, is filled out by the *Auditing Department* and kept in its files. Detailed information is entered on a separate card for every motor, machine or other piece of equipment in the plant, including typewriters, furniture and so on, and these cards form a complete inventory of the works equipment. As will be seen from the illustration, the data recorded includes, besides the general description, make and number of the equipment and so on, the purchase price, cost of transportation and installation, the depreciation per year, the location, improvements made and the cost and the repairs needed, with the cost of making them.

**Fig. 13—Stock record form used by the storekeeper.**

These forms are employed in keeping account of materials which are normally carried in stock. The date and quantity received are entered in the proper columns, and against these are recorded the date and amount withdrawn, the department to which it went and the balance left in stock. The minimum amount to be carried is shown in the upper right-hand corner, so that the ordering of new material for stock is almost automatic.



Stores Stock Record

Western Clock Co.

Name Copper Wire (#14 Rubber Covered) Sect. J Row C Box 1

Description No. 14 B&S Gauge Solid Double Braid (Rubber Covered) 30 feet per lb. Min. 4000 ft.

| Receipts | | | | | | Delivered | | | | Delivered | | | | Delivered | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date Ord. | Date Due | Inv. No. | Shipper | Date Rec'd | Quantity | Date | Quantity | Dept. | Balance | Date | Quantity | Dept. | Balance | Date | Quantity | Dept. | Balance |
| 3/20/21 | | | WEC | 4/6/21 | 3000 | 3/9/21 | | | 300 ft. | 4/1 | 235 ft | Job 76105 | 4665 | 7/19/21 | 58 ft | 76913 | 7497 |
| 3/9/21 | | | [illegible] | 5/15/21 | 5000 | 3/10/21 | 300 ft | Bldg. O | 0 | 6/21 | 35 " | 76440 | 4630 | 7/20/21 | 15 | 76952 | 7482 |
| | | | | 5/5/21 | 87 | 4/11/21 | | | 3000 ft | 5/3/21 | 190 ft | Bldg O | 4440 | 7/23/21 | 280 ft | 76198 | 7202 |
| 5/11/21 | | | | 5/26/21 | 5000 | 4/16/21 | 75 ft | Main | 2925 ft | 6/2/21 | 40 " | Fruit Co | 4400 | 7/22/21 | 77 " | 76143 | 7125 |
| | | Job 76487 | | 6/10/21 | 124 ft | 4/18/21 | 1000 " | Planing | 1825 " | 6/9/21 | 198 " | Job 76724 | 4202 | 7/29/21 | 88 " | 76161 | 7037 |
| | | Job 76724 | " | | 186 " | 4/20/21 | 90 " | " | 1735 | 6/10/21 | " | " | 4326 | 7/30/21 | 25 " | 76320 | 7009 |
| | | Copper Co | | 6/23/21 | 624 ft | 4/22/21 | 140 " | Truing | 1595 | " | " | " | 4514 | 7/30/21 | 185 " | 76123 | 6815 |
| 6/15/21 | | Copper Co | | 7/21/21 | 5000 | 4/21/21 | 125 " | Planing | 1470 | 6/14/21 | 75 ft | Bldg. O | 4437 | 8/2/21 | 225 " | 76345 | 6590 |
| | | Job 76148 | | 7/3/21 | 63 | " | 15 | Auto Sp. | 1455 | 6/23/21 | | | 4499 | 8/3/21 | | | 6653 |
| 8/16/21 | | WEC | | 7/27/21 | 3000 | 4/25/21 | 32 ft | Truck | 1423 | 7/3/21 | 30 ft | Job 76162 | 4469 | " | 320 ft | 76274 | 6333 |
| | | " | | 8/11/21 | 3000 | 4/29/21 | 60 " | Baffle | 1363 | 6/30 | 250 " | 76147 | 4219 | 8/5/21 | 135 | 76431 | 6198 |
| | | | | | | 4/30/21 | 160 " | Pulley | 1203 | 7/31/21 | 286 " | 76167 | 3933 | 8/27/21 | 425 | 76311 | 5773 |
| | | | | | | 4/25/21 | 1200 " | " | 3 | 6/1/21 | 460 " | 7485 | 3473 | 8/27/21 | 60 | 76470 | 5713 |
| | | | | | | 5/5/21 | | | 90 | 7/11/21 | 450 " | 76852 | 3023 | 9/9/21 | 460 | 76391 | 5253 |
| | | | | | | " | 90 " | Bldg 15 | 0 | 7/13/21 | 45 " | | 2978 | 9/9/21 | 335 | 76331 | 4918 |
| | | | | | | 5/14/21 | | | 5000 ft | 6/21 | 47 " | 76542 | 2931 | 9/9/21 | 24 | 76457 | 4894 |
| | | | | | | 5/14/21 | 100 ft | Top Co | 4940 " | 7/16/21 | 47 " | 76652 | 2884 | 9/9/21 | 72½ | 76437 | 4822½ |
| | | | | | | " | 330 " | Bldg O | 4610 | " | 15 " | Frank Co | 2869 | 9/21/21 | 52½ | 76768 | 4869 |
| | | | | | | 5/16/21 | 30 " | Frank Co | 4580 | 7/17/21 | 10 " | Stock | 2849 | 9/23/21 | 24½ | 76514 | 4845½ |
| | | | | | | 5/17/21 | 1500 " | Bldg O | 3080 | " | 18 " | 75710 | 2831 | 9/24/21 | 47 | 76468 | 4798 |
| | | | | | | 5/21/21 | 1000 " | Shop Feed | 2080 | 7/18/21 | 20 " | Baffle | 2819 | 9/24/21 | 6 | 76617 | 4792 |
| | | | | | | 5/21/21 | 500 ft | Frame Mfg | 1580 | 7/19/21 | 285 " | Pulley | 2534 | 9/24/21 | 33 | 76579 | 4761 |
| | | | | | | " | 60 " | Platen | 1520 | 7/18/21 | 6 " | Comm | 2728 | 9/24/21 | 56 | 76595 | 4705 |
| | | | | | | 5/24/21 | 500 " | Bldg O | 1020 | 7/20/21 | 40 " | 75605 | 2688 | 9/16/21 | 48 | 76616 | 4657 |
| | | | | | | 5/25/21 | 504 " | Main | 520 | 7/21/21 | 95 " | Frame | 2593 | 9/15/21 | 38 | 76649 | 4619 |
| | | | | | | " | 100 " | Stock | 420 | 7/21/21 | | | 7593 | " | 675 | 75803 | 3944 |
| | | | | | | 5/24/21 | | | 5420 ft | 7/30/21 | 4 ft | 75977 | 7589 | 9/16/21 | 8 | 76689 | 3936 |
| | | | | | | " | 75 " | Stock | 5345 " | 7/22/21 | 6 " | 74274 | 7583 | 9/20/21 | 3 | 76590 | 3933 |
| | | | | | | 5/28/21 | 60 " | Tin Co | 5285 " | " | 4 " | " | 7579 | 9/22/21 | | | 6944 |
| | | | | | | 5/28/21 | 70 " | Stock | 5215 " | 7/25/21 | 10 " | | 7569 | 9/24/21 | 500 | 76643 | 6411 |
| | | | | | | 5/28/21 | 215 " | Bldg | 4900 " | 7/27/21 | 14 " | 74807 | 7555 | " | 750 | " | 6911 |

After the motor has been in service for a time and needs repairs, such as the replacing of a burned-out armature coil, the procedure is as follows: An order, not shown here, is made out on the form in Fig. 3, for the necessary repairs. After these are made they are duly noted on the record card for this motor, Fig. 9, kept in the *Maintenance Department* files.

Somewhat later it may be decided to install this motor on machine No. 31243 in the *Experimental Machine Shop.* A *Transfer of Property Order,* Fig. 11, is then made out. No property or equipment can be moved without an order like this. When a motor or other piece of equipment is installed in a department it becomes in effect the property of that department and may not be moved without the foreman's knowledge. A release must be obtained, regardless of whether the equipment is idle or in use. This procedure not only makes it much easier to keep the records straight, but prevents unauthorized and perhaps unwise transfers of equipment.

This transfer order is issued in duplicate, the original (white) sheet going to the *Maintenance Department* and the second (yellow) sheet to the *Auditing Department.* When the transfer order is received by the *Maintenance Department* it is entered on the *Maintenance Orders Index,* Fig. 5, and then turned over to the millwright foreman. After the motor is moved and the electricians have connected it up, the order is returned to the head of the *Maintenance Department* for filing. At the same time the new location and date of transfer are entered on the *Motor Record Card,* Fig. 9.

The foregoing procedure illustrates the routine followed in the purchase of special equipment, as distinguished from equipment or supplies which are normally carried in stock. The routine for the purchase of this latter class of material is considerably more simple. The stock of all such items, for example, as wire, fuses, sockets and the like is kept up by a simple, perpetual inventory card system. The *Stores Stock Record* used for this is shown in Fig. 13. A separate form is, of course, made out for each item. The quantity, date of order, receipt, and so on are entered on the left-hand side of the card. As deliveries to the various plant departments are made, the date, amount, department receiving the material and the balance left in stock are entered in the columns reserved for this information. The storekeeper can thus tell by a glance at the corresponding form just how much of a certain material or item is on hand. The minimum amount to be carried in stock is indicated in the upper right-hand corner of the form and when the amount in stock reaches or closely approaches this figure, the storekeeper fills out a purchase requisition for the material needed to build the stock up to the desired point. If there is a possibility that there will be an unusual demand for the material in question, or that it is desired to change to a grade, kind or manufacture different from that which has heretofore been used, the stockkeeper will confer with the head of the *Maintenance Department* before sending the purchase requisition to the *Purchasing Department.* Otherwise, he sends it in direct. After this the procedure governing the making out of the receiving tickets, withdrawal of material for use and so on are as already described.

After it is received and properly checked and recorded, all material with the exception of motor brushes is stored, in a stockroom devoted exclusively to maintenance supplies, in sectional steel cabinets approximately 6 ft. high, 2½ ft. wide and provided with shelves. The upper half of these cabinets is 1 ft. deep and the lower half 2 ft. deep. Stock can thus be kept clean and readily accessible. For the sake of greater convenience, the stock of motor brushes is kept in a locked steel cabinet in the motor repair shop.

**Fig. 14—Testing bench in motor repair shop.**
Motors which have been repaired are thoroughly tested out before they are again installed. Also, motors which overheat or show other signs of trouble are carefully examined and tested to locate the cause of the trouble. By the use of a lampbank and a suitable arrangement of switches it is possible to test the motors at almost any desired voltage.

Between 1,200 and 1,300 motors are employed to drive the various machines in the factory. These motors range in size from 1/20-hp. to 55-hp. The average size of the majority of the motors is ¾-hp. They are all direct-current motors and those above ⅛-hp. operate at 220 volts. Motors smaller than this operate at 110 volts. New machines are constantly being installed in the factory and changes from belt drive to motor drive are frequent; consequently, a reserve stock of 3 to 5 new motors for each size from ½-hp. to 3-hp. is always kept on hand to take care of demands from these sources. In addition, from 15 to 20 motors of various types are kept in stock as replacements for motors which give out in service. About 25 spare armatures, 2 per cent of the motors in operation, are also maintained as replacements. That this low reserve of motors and armatures is sufficient to meet the demands is due to the care taken to see that motors are properly (*Continued on page* 362)

*How Waste of Labor and Time Is Being Eliminated in*

# Intra-Plant Transportation of Materials

## *By Dispatching Electric Trucks and Studying Operation Costs*

**THIS ARTICLE describes the operation of a system whereby trucks are at all times under control of truck foreman, who directs their travel so that runs without load are kept to a minimum. The system also includes periodic inspection and overhauling, which must be vigorously followed if the trucks are to be kept running, and a method of analyzing costs.**

By J. ELMER HOUSLEY

*Formerly Electrical Engineer, Aluminum Ore Company, East St. Louis, Ill.*

INDUSTRIAL trucks are a real factor in eliminating waste of labor and time. Much thought, however, must be given to securing the most effective use of them. The movement of the trucks in operation must be directed and controlled and the mechanical health of each machine must be guarded and not allowed to break down.

Also to check the results of their service, a long test of costs, or better, a continuous cost record, must be kept. In the plant where the writer was electrical engineer these things were worked out in a very successful way. In this plant fifteen trucks and one tractor with four trailers are operated. Five of the trucks and the tractor and trailers are used in miscellaneous hauling.

When a truck is required to haul some material the foreman or workman on the job calls the truck garage over the automatic telephone system, which has stations at convenient points throughout the plant, and gives the truck foreman the job number covering the material to be hauled, the nature of the material, the building or station where located and the point where the delivery is to be made. This memoranda is noted on a form sheet called the "Industrial Truck Daily Report," which is reproduced on page 326. The time of receipt of the order is noted, also the truck and driver to whom the trip is assigned. Several pickups may be assigned to a driver on one trip through the plant. After each trip the driver returns to the truck garage if near that point, otherwise he calls up from the nearest automatic 'phone station to receive any further assignments. In this way long trips running unloaded are avoided and the greatest possible number of ton-miles is hauled. Repairs or replacements on shop machinery in a majority of cases can be made by millwrights using the truck service, without calling out a rigging gang of four to seven men to help handle a piece of machinery.

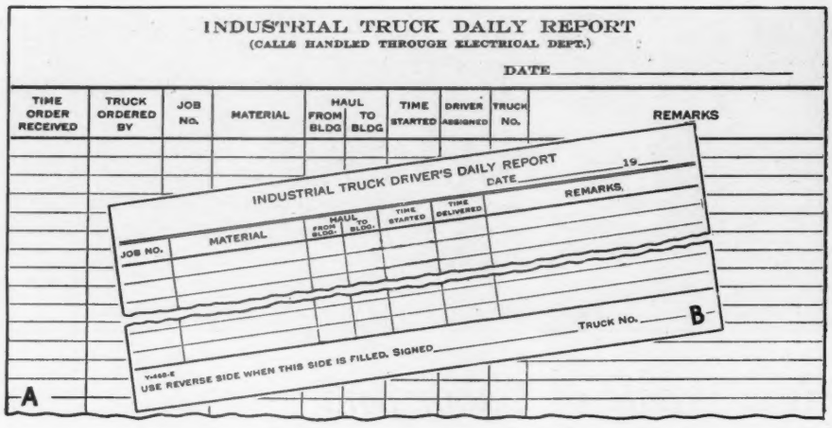
### Preventing Loss in Loading or Unloading Time

A dispatching system which fulfills its mission of prompt and efficient delivery lacks a most vital element unless provision is made to secure and supervise immediate loading and unloading of trucks and

**Tractors and trailers, as well as trucks, should be dispatched and not allowed to stand idle.**

**Forms which keep the trucks doing useful work and serve as records.**

*A.*—The jobs are entered on this sheet as they come into the office. After the driver is sent out with a truck the sheet gives information regarding time of leaving and work to be done. If a truck is unreasonably delayed in doing a job, investigations are made. The card shown at *B* is kept by a driver during a day. The information which he puts on it is particularly valuable in estimating the cost of operating trucks.




trailers. It is particularly difficult to have a trailer unloaded quickly. The workmen apparently prefer removing the material from the trailer as needed instead of piling it on the ground and permitting the trailer to go to other jobs. The writer has found the "Industrial Truck Daily Report" to be as effective in checking movements of trailers as for the trucks. When following the movements of the trailers, if the tractor driver reports the trailers as not being cleared within one hour after delivery, the truck foreman calls the foreman in charge of the job on the phone and informs him of the delay. This usually suffices to get the trailer cleared immediately, and only in rare instances is it necessary to report neglect with respect to loading and unloading to the department heads. As an instance of saving in equipment necessary to handle a given job, just before we installed the dispatching system, four trailers were in constant use and we believed that at least eight trailers would be required later to handle effectively the intra-plant transportation of bulky materials. After a complete survey of the running time of the trucks and trailers it was decided to install the dispatching system, which thereafter performed its mission so well that the four trailers handled all the hauling, with a trailer always at hand for a call.

In handling the large number of deliveries, running as high as 270 in one day, disputes frequently arise as to delays and misplacements of material, and in order to provide a written record by the driver delivering the material, we supplied each driver with a 4-in. by 6-in. printed form called "Industrial Truck Driver's Daily Report," which provides a space for the job number, material, point of origin and destination, time started on trip and time delivered. Under a "Remarks" column the driver noted the time of delays in loading or unloading or any other irregularities in his work.

### Dispatching Applied to Storeroom Delivery

After noting the satisfactory solution of plant hauling problems with a dispatching system, a somewhat similar method was installed by the storekeeping department. The object of this system was to prevent the necessity of mechanics and helpers leaving their work to secure a requisition from their foreman, then going to the storeroom, waiting for their order to be assembled and returning to the job. Where the material was heavy, an additional delay was occasioned by ordering a truck to haul the material for them. Under the storeroom delivery system the workman or foreman telephones to the storeroom and the storeroom delivery clerk writes out a requisition as given by the man over the 'phone. Two trucks were assigned to the storeroom and drivers were furnished by that department. When a number of orders are filled, a truck is started out to deliver the material to the job designated and the driver takes a set of requisitions covering the material, to be signed by the person receiving the material. The average cost of each delivery was found to be nominal and it decreased as the number of deliveries increased

**Intelligent direction in operation will get the most out of industrial trucks.**

**For routine manufacturing processes trucks may be assigned permanently to different departments.**

after the foremen had been induced to enter into the spirit of the thing and to realize the saving in time required to do the jobs when the workmen did not leave the work so often.

### Some Trucks Assigned to Regular Daily Duties

Besides these trucks which are kept on hand, other trucks are sent out daily on routine jobs and to different departments for their exclusive use. Trucks doing such work do not report to the truck foreman except on coming back to the garage at night. The truck foreman, however, is in responsible charge of the garage and all battery-charging and repair equipment. Any trouble on the trucks is reported to him immediately. The driver of a truck assigned to routine jobs may be furnished by the department using the truck; however, the driver should be held responsible by the truck foreman for misuse of the trucks.

The handling of material in process very often presents a specialized problem and trucks are bought and used as dictated by the requirements of the product.

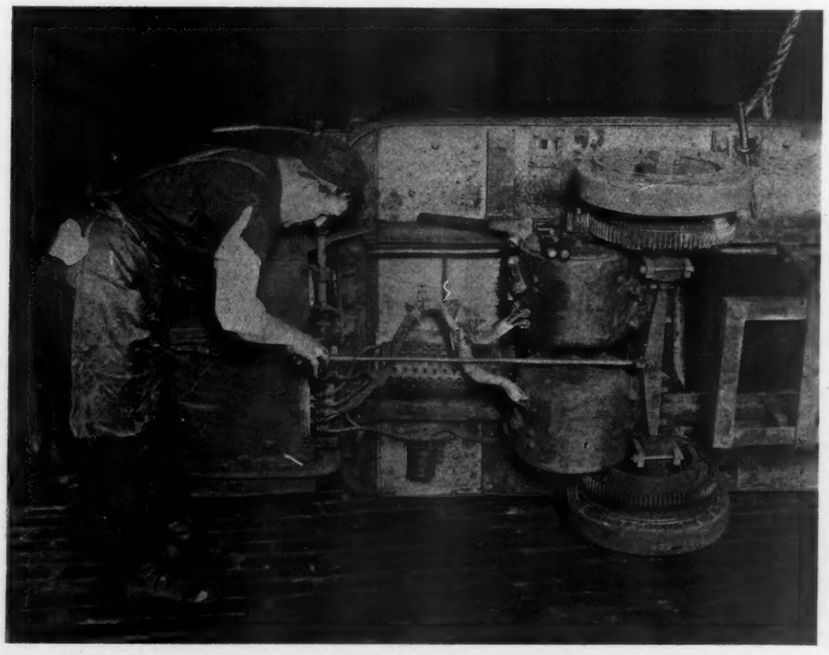
For yard cleaning, a dump-body truck is usually employed for properly collecting the debris from building operations or from sweepings which may be collected from well-placed refuse cans. The iron and other materials which are scrapped from repair or construction jobs may be collected on platform trucks and hauled to a reclaiming department or to the scrap yard. These trucks may be operated by drivers working under the supervision of the yard foreman.

In practically all large industrial plants a reclamation department is operated to salvage all material which is discarded and which may be either repaired and returned to stores or which may be carefully sorted and sold at a higher price than miscellaneous scrap. For this work a platform truck may be assigned to move material about the scrap yard and to deliver salvaged material to the storeroom.

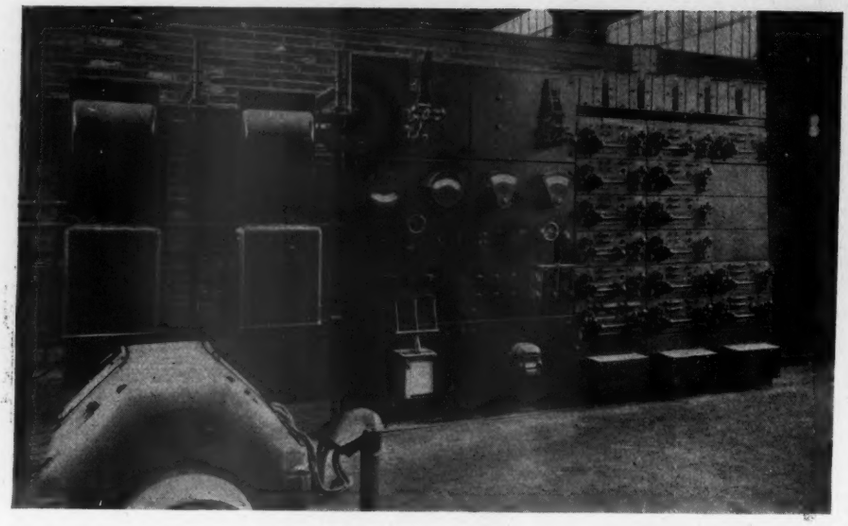
In the intra-plant transportation of repair parts, motors and construction materials the dispatching system is used. For the most part platform trucks may be utilized for motors, machinery and tools, but a tractor with trailers is best adapted to handling construction materials such as cement, brick, lumber and iron. The great saving in labor by the use of trucks comes in the elimination of rigging gangs for moving machinery on skids or on hand trucks, as each truck will eliminate five or six men in transporting material. Another saving comes in hoisting material to the upper floors of buildings, as a truck may be hitched to the line from a block and tackle and quickly hoist the material.

### Housing and Maintaining Trucks

From the writer's experience with a large number of trucks, it has been found desirable to segregate the truck in a garage, which may be a partitioned section of one of the shop buildings, so situated as to be under close supervision of the electrical department. The floor should be of concrete, with drains so that the running gear of the trucks may be thoroughly cleaned with a good stream of water. Convenient outlets should be provided for charging from a central charging board. A room for battery repairs should be provided, in order that the tools and equipment may be locked up in the absence of the repair men. This room may be made large enough for the dismantling of trucks for heavy repairs and so prevent the small parts from being scattered promiscuously over the open garage. It is not al-



**Maintenance work is quicker and easier if the truck is turned on its side.**



**A well arranged charging switchboard.**
This board at present takes care of seventeen trucks. At the left-hand side there are two starting panels, the first for tests and the second for the charging generator. The charging generator panel has a 600-amp. switch and circuit breaker with direct-current ammeter and an alternating-current-input watthour meter. There is space on this panel for an additional charging generator. Fifteen sectional Cutler-Hammer charging panels are shown at the right. These panels are standard 125-volt units with enough resistance to reduce the potential to 85 volts. At the bottom are shown change-over switches for cutting down the potential from 220 to 85 volts when it is not desired to run the charging generator.

ways practicable to lock up the main garage section, owing to the remote risk of a fire originating while the batteries are being charged during the night or in case certain trucks are used by the night repair gangs.

The trucks should be washed regularly, the interval of course depending on the plant conditions and the dirt accumulated. The dirt works into the bushings and bearings and rapid wear is the result if attention is not given to thorough cleaning. If the hose is not directed on the battery, motor or controller, no trouble will result in the electrical system from the washing.

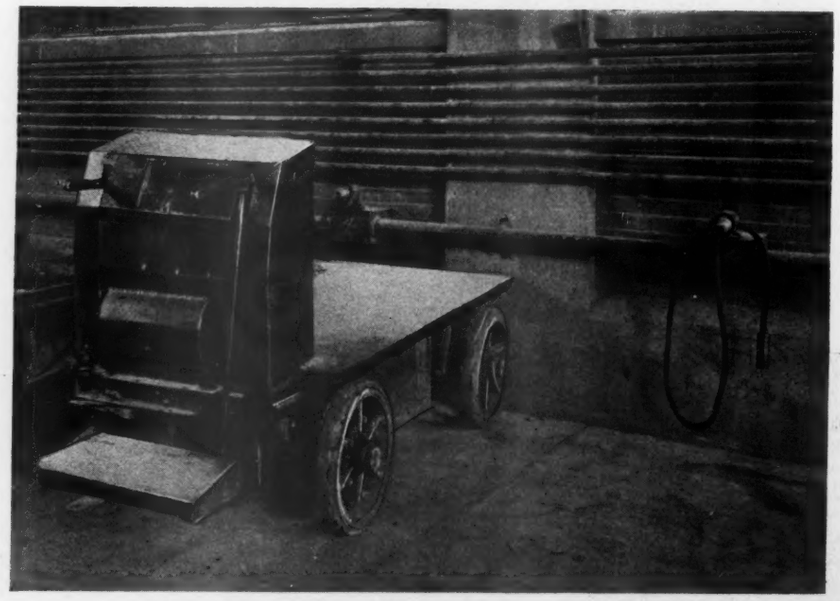
At the beginning of each day's work the driver should be required to oil his machine thoroughly and turn up all grease cups, filling them when necessary. In the interest of safety, each driver should be held responsible for keeping his brakes sufficiently tight and his warning horn in operating condition at all times.

A monthly inspection should be made by the workman in charge of the trucks, taking the trucks in rotation, and making any adjustments necessary. If chain drive is employed, the chains should be carefully adjusted to avoid breakage from slackness. The steering gear should be examined and the wheels checked for alignment. It is desirable to clean the commutator and brush rigging in order to prevent the brushes sticking and burning the commutator. Enclosing covers must be kept on the motors. When a motor cover is lost, a temporary cover made of tin may be taped in place until a new one can be secured. The controller should be included in the monthly inspection. Attention to the tension of the controller finger springs and to any burned finger tips is important. Unless the controller fingers are regularly smoothed up with a file and the surfaces greased with vaseline, a high-resistance contact often develops which anneals the springs and puts the truck out of commission. The greatest amount of trouble, as might be expected, develops with the auxiliary switch which is used to interrupt the main circuit when the driver releases the foot brake. Sometimes this switch is quite inaccessible, and if so, it usually pays to change the location or even to secure a different switch which may be put in a location where repairs and inspection can easily be made, since minor repairs will be neglected if considerable dismantling must be done. Breakdown or failure of control equipment is the aftermath of neglected inspection and minor repairs.

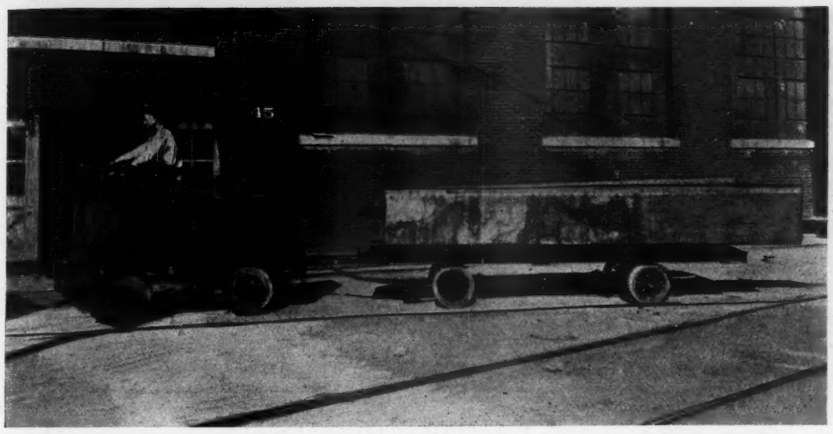
During the monthly inspection the springs of the truck should be closely examined and any broken springs replaced. Continued running with a broken spring will warp the frame and loosen the rivets of the cross members. Fractures of the side channel-iron members have sometimes resulted, evidently caused by torsional strain coupled with bending moments from heavy loads.

### A Truck Needs a Complete Overhauling Yearly

It is essential that the working parts of a truck be given an annual overhauling. The truck should be dismantled, all bearings and exposed wearing parts being cleaned with kerosene or some cleaning solution. Any bushings or bearings which are worn excessively should be replaced. Where pin joints are not originally furnished with brass bushings the holes should be reamed out and bush-



**Charging plugs and conduit lines in the truck room.**
A separate room should be used for storing, charging, and repairing industrial trucks.



**Use of trailers will prevent overloading of trucks.**

ings fitted to keep the parts free from lost motion and to prevent the wearing of levers and cranks.

After the roller and ball bearings have been examined for defects these parts should be packed with grease and reassembled. A careful scrutiny of the parts of the truck will reveal any places which are not being lubricated properly. This may be due to restricted passages or improper fitting of parts and the trouble may be rectified during reassembly. In one instance the writer found it necessary to drill the casing of the worm-drive assembly of a truck and add an oil cup over the thrust bearing, which did not receive sufficient oil from the differential case through an unusually long oil groove.

### Replacements Which Are Most Likely to Be Necessary

In the course of time the rivets in the frame of the truck should be knocked out and replaced by new rivets hot-riveted in place. It is well to examine the channel side frame for signs of initial fractures as it is very much easier and cheaper to renew a side frame when the truck is dismantled than to allow a break to occur under load with possibilities of greater damage. In a few trucks the frame is narrowed at one end and where the frame is bent this has been found at times to be the seat of the initial fracture. Other fractures are often due to an excessive number of holes in the frame. One solution to the problem of overloading platform trucks lies in encouraging the use of trailers for heavier loads where speed is not the prime consideration.

A number of trucks which have been given such a periodic inspection and overhauling have been in active service over five years and apparently do their work quite as efficiently as when new. Having had all necessary renewals of their wearing parts, the various units of the trucks appear good for many more years of useful service. It is far cheaper to maintain the repairs of the trucks on a rigorous plan than to neglect them and let the heavy investment go to the scrap pile in a few years. Worn parts if not replaced will eventually wreck the more permanent parts of the truck, such as the motor, controller, transmission and chassis. Where the number of trucks in service is large, the repair parts should be kept in the regular plant storeroom in bins labeled with the correct catalog numbers. When requisitions are presented they should bear the correct part number in order to prevent unnecessary waste of time to secure the proper charging of the item.

The expense due to tire replacement amounts to a considerable item where trucks are in continuous use with heavy loads. In the average industrial plant the tire cost per truck will usually amount to five or six dollars per month per truck with a life of nine to twelve months per set of tires. The condition of the plant roadways and the usual numerous railroad crossings greatly affect the life of rubber tires. Where approaches to buildings or crossing of pipe trenches are made of sheet iron no upturned edges on the plate should be exposed to cut the tires since many investigations of the destruction and excessive wear on tires have shown conditions that caused an initial cutting and rapid disintegration of the tread of the tire.

### Batteries and Charging

The use of storage batteries in automobiles has greatly enlightened people as to the dependability and utility of this equipment. When the deleterious effects of high temperature from either excessive discharge rates or prolonged high charging rates are understood and avoided, and the proper water level in the cells and scrupulous cleanliness are maintained, it is almost certain that the maximum life will be obtained from the battery. The details of the charging rates for the various batteries should follow the manufacturers' instructions as closely as possible. Distilled water should be used in the batteries and where there are several batteries it is often convenient to install a still operated by gas or electricity.

One of the best safeguards in the operation of any industrial truck is the ampere-hour meter. The meter should be connected to register charge and discharge. A circuit breaker should be installed to trip out the charging circuit when the meter shows a full charge. With the meter and circuit breaker mounted on the truck the complication of a pilot wire is eliminated. Records show that about 75 per cent less water is required to be added to the battery when using a meter, since a more accurate check is kept on the input and the temperature of the battery on charge is kept down by eliminating overcharging.

Performance and service records for many plants require an ampere-hour meter equipped with totalizing dials in order to check the individual performance of batteries. An odometer, which fastens to the hub cap of the wheel, may be used to secure data on the number of miles traveled.

Dirt is often the cause of serious damage to the tops and trays of batteries. The tops of the batteries should be blown or brushed clean and the metal parts kept covered with grease. The Edison cells may be covered with a film of oil to prevent the collection of corroding materials which tend to destroy the terminal-post insulators.

Where loss of capacity, dead cells and separator failures are encountered, the service department of the battery company should be advised even if the repairs are handled by the plant organization. This enables the battery companies to improve their product and their advice based on broad experience is valuable.

Charging equipment should be carefully considered and attention should be given to the future requirements of the plant. Various types of (*Continued on page* 360)

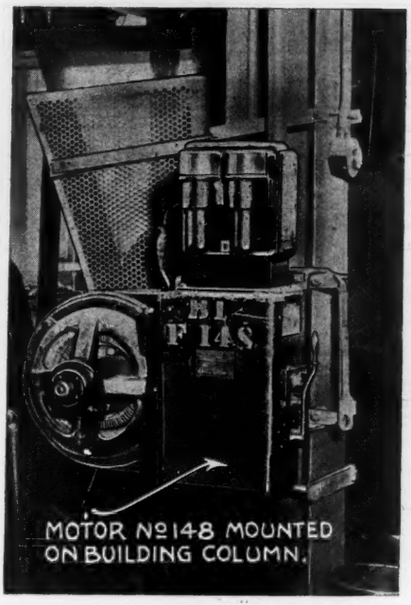
THIS ILLUSTRATION shows an unusual mounting of several motors on the ceiling where they are out of the way and free from dirt. With the starting compensators mounted together on a single supporting frame centralized control is secured. The letters and numbers on the bank of compensators at the left illustrate the designation scheme, which is described in this article, as carried out in the plant of the Crane Company in Chicago.

# How Motors Are Located And Identified

## *In a Large Works by a Simple Combination of Letters and Numbers*

A SERIAL motor number, a building location number and a building column number form the basis of an effective scheme of motor identification and location records employed in the plant of the Crane Company, Chicago, Ill. The serial motor number is painted in white on the motor frame as soon as it is received at the plant. The building location numbers each include two letters and a numeral so chosen that the complete number tells the location of the building on the property and the floor of the building under consideration. The building column numbers include one or more letters and a number. The rows of columns are numbered in one direction and lettered in the other, so that a combination of letter and number will definitely locate a given column.

By combining the motor number and the building location number a complete motor identification is made. For example, C 2—F 124 indicates the location of motor No. 124 as being in building C 2 on the (F) first floor. The basement of the same building would be designated as C 2—B, the second floor as C 2—S. If there were a charging floor in building C 2 it would be designated as C 2—C. The plant buildings are only two stories high, so that the designations B, F, S and C are sufficient to cover the various requirements of floor locations, including basement, first, second and charging floors. Building numbers such as A 1, B 2, and so on, are assigned in an order that may be observed in the accompanying property diagram. The buildings are arranged in rows, the A row running along the north end of the property, with the B, C, D, E and F rows coming in order to the south. In the rows the buildings



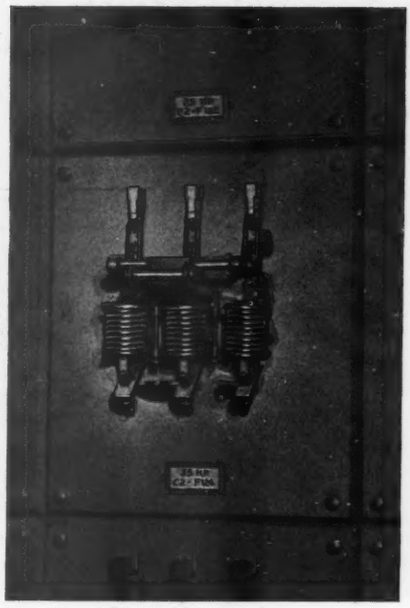

**Method used in mounting motor and compensator on building column.**
In this installation it may be noted that the motor is completely shielded from mechanical injury by the building column, the driven machine and the pulley guard, and yet it is accessible for cleaning, inspection and oiling. This mounting is well adapted for the jack shaft drive required on the tumbling mill.

are numbered from east to west, so that a letter and number together represent a specific building, the location of which is easily determined by anyone knowing the general numbering scheme.

As a more detailed record of motor location, "motor list" sheets were made out at the time the plant was erected. These "motor lists" were made out by buildings and give the location, number, horsepower, speed, column location of compensator, application, and the like, of each motor, as may be noted from the illustration on this page showing a portion of one of these lists. The column locations of the compensators show just where in the building the compensator for the given motor is located. The rows of building columns are numbered from north to south and lettered from east to west, so that the exact location of a motor and its compensator within the building is determined by each numbering.

### General Arrangement of Power Supply

Energy for the operation of all motor equipment is supplied by eight substations located so as to give economical distribution, as shown in an accompanying diagram, page 333. All motors, except some of the small units, are supplied by individual feeders running direct from a circuit breaker on the substation switchboard to the motor compensator located at a point convenient for the control of the motor. In some cases two or more small motors are supplied by one feeder and one circuit breaker on the substation board.



**Motor numbers are shown under each motor circuit breaker.**
A card mounted on each circuit breaker panel shows the horsepower, the building, the floor and the number of the motor supplied by that particular circuit breaker. This information aids the operator in handling the equipment in case of trouble and greatly reduces the chances of error or accident.

On the substation board the circuit breakers are mounted on small panels arranged in rows and columns, as may be noted from the illustration on page 333. Each circuit breaker controls a signal switch that is closed when the circuit breaker

## This is a Sample Form of the "Motor List" Used as Record of Exact Location and Duty of Each Motor

| Motor Location | Motor No. | H.P. | R.P.M. | Frame No. | Base | Pulley, | | Column Location of Compensator | Application | Notes | Motors Marked "X" Not Used | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Dia. | Face | | | | X | Date Exempted |
| E5-F | 456 | 75 | 900 | | | | | | | | X | Apr. 6, 1917 |
| E5-F | 625 | 15 | 1200 | | | | | Z2 | Draw Shaper | | | |
| E5-F | 626 | 20 | 900 | | | | | | | | X | Apr. 6, 1917 |
| E5-F | 689 | 7½ | 900 | | | | | HH9 | Bench Grinder—C. I. | | | |
| E5-B | 690 | 15 | 900 | | | | | BB27 | Sand Mixer | | | |
| E5-B | 691 | 10 | 720 | 10 | | 8 | 7 | HH19 | Floor Conveyor—18A | | | |
| E5-B | 692 | 15 | 720 | 11 | | 8 | 10 | HH17 | " " 18B | | | |
| E5-B | 693 | 50 | 600 | 13A | | | | GG18 | Blower for 66" Cupola | | | |
| E5-B | 694 | 35 | 600 | 13 | | | | GG16 | " " 48" " | | | |
| E5-B | 695 | 35 | 600 | 13 | | | | GG16 | " " 48" " | | | |
| E5-B | 696 | 75 | 3600 | Special | | | | GG15 | " " Converter | | | |
| E5-B | 697 | 75 | 3600 | " | | | | GG15 | " " " | | | |

**Data mounted on a board in substations to guide the operator.**

This table shows the switchboard section from which each motor is supplied. The diagram of the face of the switchboard shows just what motor or motors are supplied from each switchboard panel. These two charts make it possible for the operator to determine at once the relation between the switchboard and the equipment in the plant.

LOCATION OF BREAKERS ON SWITCHBOARD

| MOTOR Nº | SEC. | MOTOR Nº | SEC. | MOTOR Nº | SEC. | MOTOR Nº | SEC. | MOTOR Nº | SEC. |
|---|---|---|---|---|---|---|---|---|---|
| 61 | 5 | 109 | 7 | 146 | 14 | 341 | 2 | 560 | 7 |
| 64 | 6 | 110 | 3 | 147 | | | | | |
| 66 | 9 | 111 | 7 | 148 | | | | | |
| 78 | 1 | 113 | 5 | 149 | | | | | |
| 79 | 3 | 114 | 4 | 150 | | | | | |
| 80 | 3 | 115 | 8 | 152 | | | | | |
| 82 | 6 | 118 | 1 | 153 | | | | | |
| 83 | 4 | 119 | 1 | 154 | | | | | |
| 84 | 6 | 120 | 1 | 155 | | | | | |
| 85 | 4 | 121 | 1 | 157 | | | | | |
| 86 | 4 | 122 | 2 | 158 | | | | | |
| 87 | 6 | 123 | 3 | 159 | | | | | |
| 88 | 7 | 124 | 2 | 160 | | | | | |
| 89 | 5 | 125 | 1 | 161 | | | | | |
| 90 | 7 | 126 | 3 | 162 | | | | | |
| 91 | 5 | 127 | 2 | 163 | | | | | |
| 92 | 5 | 128 | 2 | 164 | | | | | |
| 94 | 7 | 129 | 15 | 165 | | | | | |
| 95 | 6 | 130 | 11 | 166 | | | | | |
| 96 | 15 | 131 | 13 | 167 | | | | | |
| 97 | 5 | 132 | 12 | 168 | | | | | |
| 98 | 8 | 133 | 9 | 169 | | | | | |
| 99 | 8 | 134 | 15 | 170 | | | | | |
| 100 | 11 | 137 | 10 | 171 | | | | | |
| 101 | 8 | 138 | 12 | 172 | | | | | |
| 102 | 1 | 139 | 10 | 173 | | | | | |
| 103 | 2 | 140 | 13 | 174 | | | | | |
| 104 | 3 | 141 | 9 | 215 | | | | | |
| 105 | 6 | 143 | 9 | 274 | | | | | |
| 107 | 5 | 144 | 11 | 277 | | | | | |

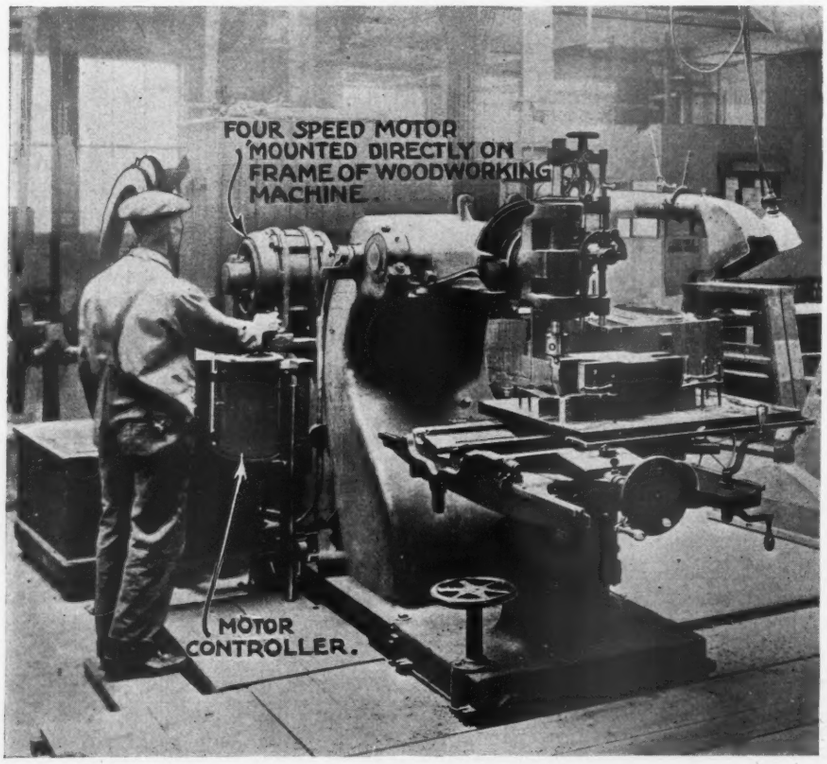
| | | | |
|---|---|---|---|
| C1-S-862 20 hp. | C2-S-104 15 hp. | C2-S-103 5 hp | Spare |
| C2-F-481 2 hp. | C2-F-80 10 hp. | C2-F-128 25 hp. | 649 C2-S-402-1 hp. C2-F-409-1 hp. C2-S-102-1½ hp. C1-B-395-2 " C1-B-471-¼ " C2-F-78-3 " |
| C1-S-85 25 hp. | C2-F-123 15 hp. | C2-F-122 25 hp. | C2-F-118 15 hp. |
| C1-S-86 7½ hp. | C2-S-110 5 hp. | C2-F-124 35 hp. | C2-F-119 15 hp. |
| C1-S-83 25 hp. | C2-F-126 20 hp. | C2-F-127 35 hp. | C2-F-125 35 hp. |
| C3-S-147 10 hp. | C2-F-79 7½ hp. | C3-F-389 7½ hp. | C2-F-121 25 hp. |
| C2-S-114 5 hp. | C2-F-342 7½ hp. | C1-B-341 5 hp. C1-B-364 5 hp | C2-F-120 15 hp. C1-B-365 5 hp |
| 4 | 3 | 2 | 1 |

Section of a Diagram Showing the Face of the Switchboard

opens for any reason. This signal switch may be clearly seen in the illustration showing circuit breakers No. C 2—F 122 and No. C 2—F 124. The signal switch when closed operates a red lamp at the top of the column of panels on which it is located and also rings a bell in the office of the assistant chief electrician. Thus the operator in charge of the station and also his superior are informed immediately in case any circuit breaker is opened. With the red light to guide him, the operator can at once "spot" the opened circuit breaker, and from the identification card on the circuit breaker panel he can see the size and number of the motor supplied by this circuit. If the operator does not report to the office the opening of the circuit breaker, the office can call him to find out just what circuit breaker has opened. From the "motor list" sheets in the office it is possible to determine the exact location of the motor supplied by the circuit in trouble. Knowing the motor number and the building, floor and column location, it is possible to send a maintenance man directly to the motor without delay.

In the case of trouble at the motor that might not result in the opening of the circuit breaker the office may be notified by telephone from the plant that a particular motor, by giving its number, is not operating. The motor number is marked plainly on the motor frame. In such a case the office informs the operator, who locates the corresponding circuit breaker by the aid of a chart mounted on the substation wall. This chart shows the switchboard section in which the circuit breaker of each motor is located, and it also shows in diagrammatic form the exact location of the particular panel. With this information and with the motor number shown on each circuit breaker panel, it is easy to locate the circuit breaker supplying the motor in trouble.

From this brief description it will be noted that motor or circuit troubles showing up in the substations may be immediately traced to the operating machine in the plant, and also that troubles evident only in the plant may be traced directly back to the source of supply in the substation. With the equipment in trouble completely located, it is only a mat-

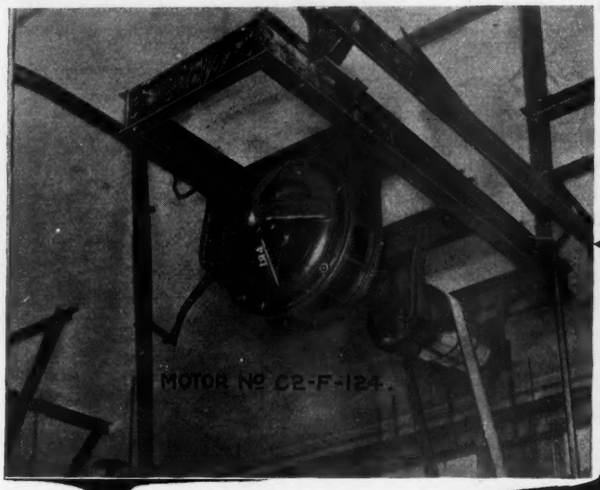


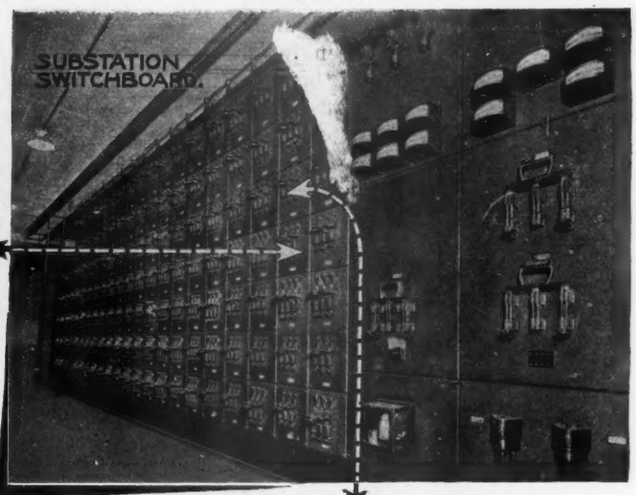

**Motor and controller mounted on woodworking machine.**

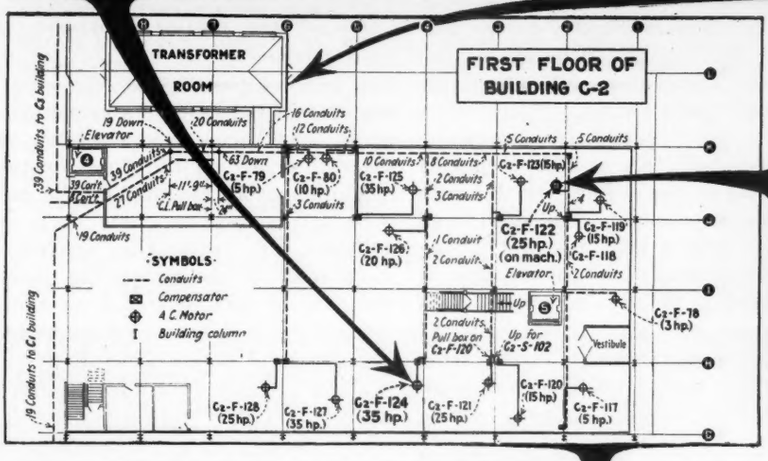
In this installation it will be noted that the motor is mounted a considerable distance away from the location of the cutting tool. Such a mounting keeps the motor comparatively free from the fine wood dust produced by such equipment when in operation. The controller is located closer to the cutting head in order to be within easy reach of the operator, for convenience and safety.

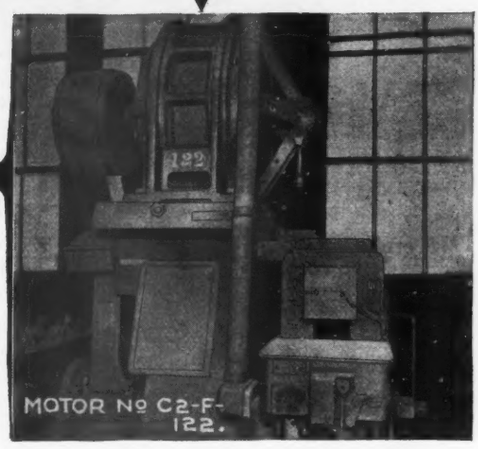
# Motor Identification Scheme

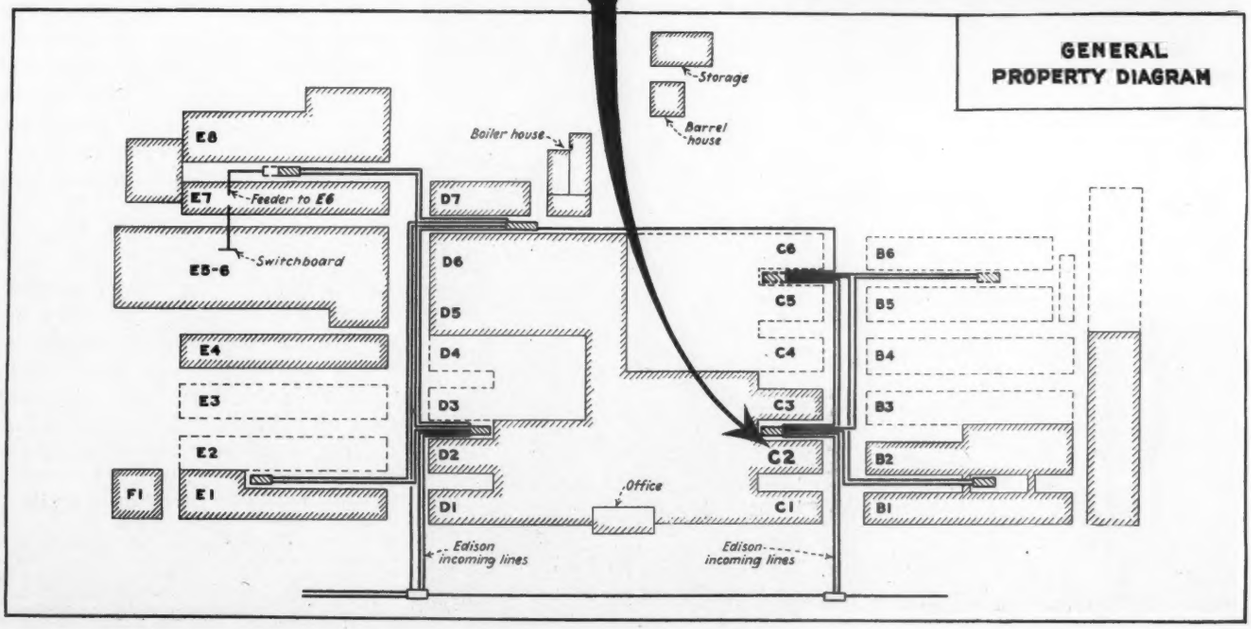
**IN THIS ILLUSTRATION is shown the general plan of numbering motors that are controlled from a central switchboard so that sources of troubles can be quickly found and a record of machine locations maintained on the floors of the various plant departments and by locations of the various buildings of the entire works. For example, the records kept show that the circuit breaker on the substation switchboard marked C2-F-124 controls Motor No. 124 on the first floor of building C2 of the general property diagram and that circuit breaker C2-F-122 controls motor No. 122 on the same floor of the same building. Both motors and their compensators bear this numbering scheme as shown in the illustrations.**

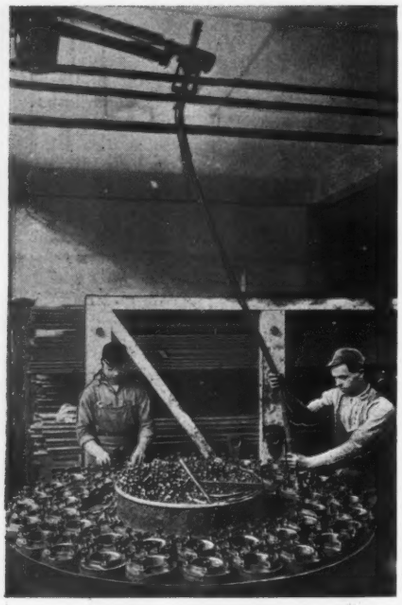




**A motor-operated wrench that speeds up the screwing down of flange nuts.**

The ceiling-mounted motor drives a socket wrench through a belt and flexible shaft. Ceiling mounting in this case makes it possible to swing the socket wrench, through the medium of the flexible shaft, over the entire area of the working table on which the flanges are set up to be bolted together.

ter of test and repair to restore normal conditions.

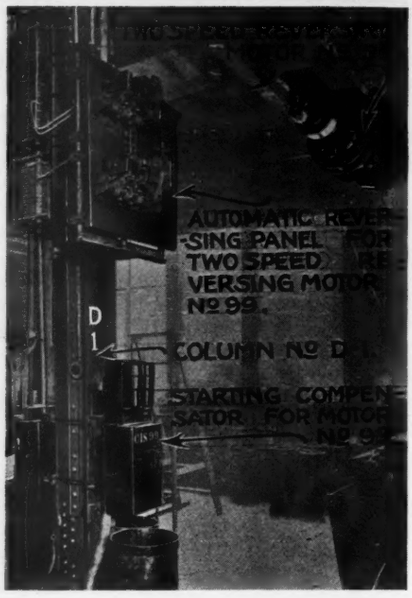
The exact position in which any given motor is located is not always fully shown by the records, although in many cases the record is sufficiently complete to serve any purpose that might be required. In the case of crane motors the "motor list" sheets show whether the particular motor designated by the given serial number is a trolley, bridge or hoist motor. Of course, in the case of a crane, the motors are all mounted on the machine itself, and the controller is carried in the crane cab. In one instance a motor, as part of a motor-generator set, is mounted on a bracket carried on a crane. This motor-generator set supplies direct-current energy for the lifting electromagnets carried by the crane.

### Examples of Specific Motor Locations

In many cases the motor is mounted directly on the frame of the machine which it drives. A note on the building floor diagram shows these cases, as may be seen by the floor diagram of building C 2 at the location of motor No. 122 (page 333). In this case the diagram also shows that the starting compensator is mounted with the motor, instead of on a building column in accordance with the general practice in this plant.

Motors supplying power to pipe threading machines are mounted with their controllers directly on the machine high enough to be out of the way yet convenient for oiling, inspection and cleaning.

One motor connected through a flexible shaft to a socket wrench is mounted on the ceiling. In this case the socket wrench may be considered as the driven machine, and it can almost be said that the machine is mounted on the driving motor. Such instances as those cited show the limits between which the mounting style of motor equipment may be varied—the motor is on a moving machine in the case of a crane; the motor may be on fixed machine, on the ceiling, or on the floor, or the machine may be mounted on the motor. Of course, in cases such as grinders, etc., where the "machine" is mounted on the motor, the motor itself is in turn mounted on some part of the building or on a suitable foundation.

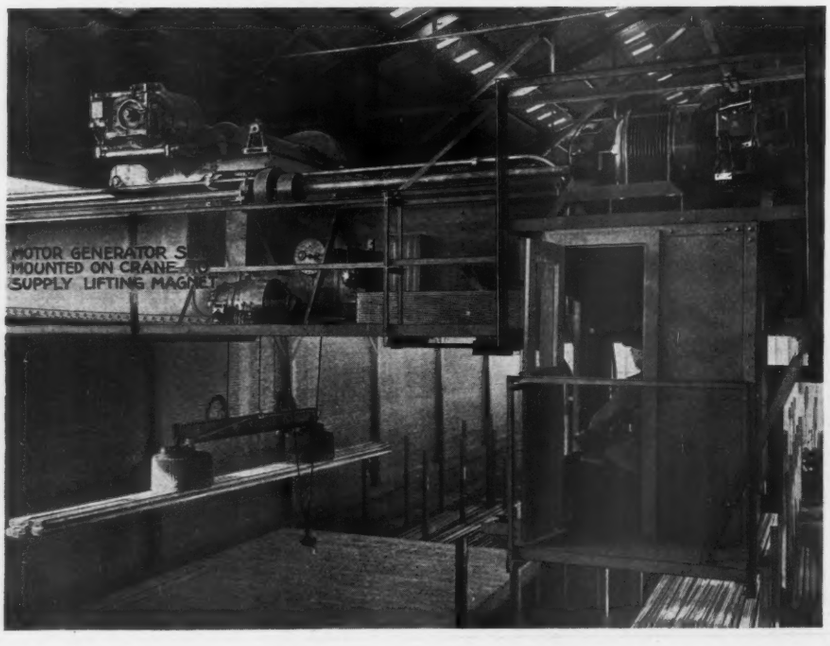



**A ceiling mounting for a reversing two-speed motor.**

Because of the nature of the driven machine belt connection is required, and ceiling mounting makes it possible to install the equipment in a safe and clean manner. The building column provides a convenient location for the starting compensator and the reversing and speed control panels.

For a number of services the motor is mounted on the floor or ceiling, while the starting compensator is mounted separate from either the motor or the machine. Under these circumstances the motor number and building numbers are printed on the compensator as well as on the motor so that there can be no reason for making an error either in operating or in maintenance work. The exact location of the compensator for each motor is shown on the "motor list" sheets opposite the motor number, the location being designated by the number of the building column on which the compensator is mounted.

Motor No. 148, located on the first floor of building B 1, is mounted on column C 4 about three feet above




**Motor-generator set mounted on the bridge of a five-ton crane.**

This motor-generator set is used to supply direct-current energy for the lifting magnets carried by the crane, alternating-current being taken from the regular supply lines on the crane.

the floor. The compensator for this unit is mounted on the side of the same column. This motor drives a tumbling mill mounted on the floor near the motor, the required connection and speed reduction being made through belts and a jack shaft suspended from the ceiling. A mounting of this type leaves the motor easy of access for oiling and cleaning and still keeps it in a safe position. The column guards the motor from mechanical damage, and mounting above the floor keeps it away from the dirt.

Motor No. 99, located on the second floor of building C 1 is mounted on the ceiling near column D 1. This particular motor is built for two-speed reversing duty and has its reversing and speed changing panels mounted on column D 1 just above the starting compensator. Belted connection is used with this equipment to secure the needed flexibility, and ceiling mounting is required to keep the belting out of the way of persons working around the driven machine. In addition, the ceiling position puts the motor out of the floor dirt and protects it from mechanical injury liable to result from the moving of trucks about the floor.

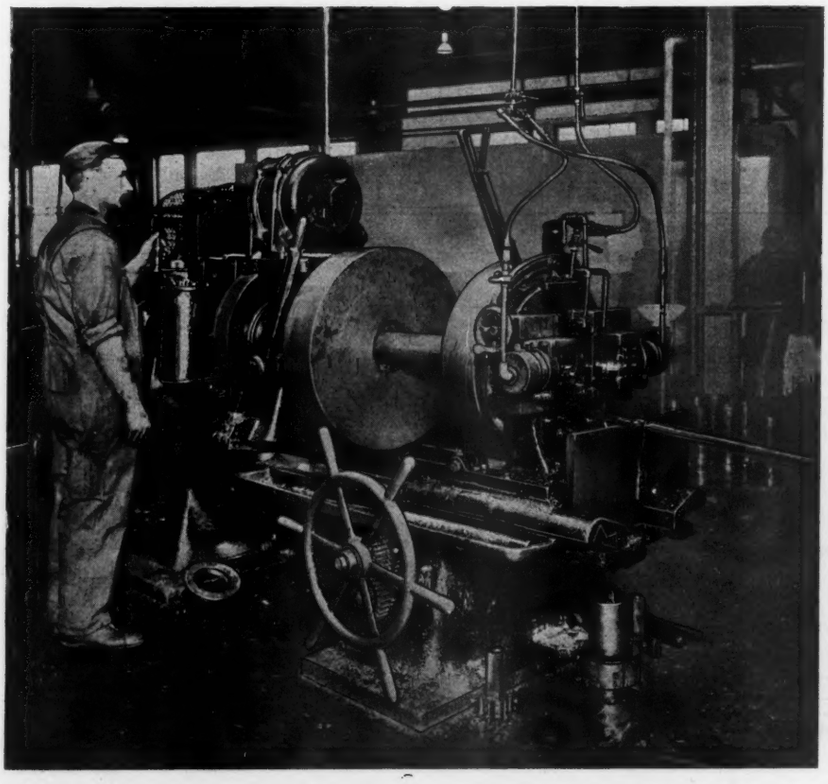
In one instance (shown in the headpiece illustration on page 330) six separate small motors are required to supply power to one small milling machine. These motors are all mounted in a circle on the ceiling with the pulley ends of the motors pointing in to the center of the mounting circle.

Safety, reliability, and continuity of service were all taken into consideration in the locating of each motor at the time the plant was erected, and these factors are considered for each new machine installed or for each change that is made. Both safety of the equipment and personal safety of the operator and the maintenance man are considered. Safety of equipment requires that the motor with its compensator and wiring be located so that these will not be struck by material trucks or by materials being handled through the plant. Locations are chosen where oil or water will not drop onto the motor and where it will be as free from dirt as possible. These factors are equally important in assuring reliability and continuous service.

Making provision for easy inspection, oiling and cleaning helps to assure continuous service. Motors located within easy reach of the floor are more likely to be well tended than those in more difficult places; consequently, where motors are mounted on the ceiling ladders are provided of the proper height to make access easy and safe.

**Motor and controller mounted on pipe-threading machine.**

It will be noted that this motor is entirely out of the way of the operator in charge of the machine and is free from any chance of damage by trucks moving about the floor. It takes up no floor space and requires no guards to shield it from other equipment, materials or floor dirt. The controller is so located that the operator can see exactly what is being done by the machine while keeping his hand on the controller handle ready for any manipulation required.



## *Here's Some Information*

Last fall the lamp manufacturers placed on the market a Mazda B mill-type lamp of stocky construction using a coiled filament and a tipless bulb. This lamp was designed to replace carbon lamps where the service conditions were too severe to make the use of regular Mazda lamps practical.

Some people have got the wrong idea about these mill-type lamps. They seem to think they can be used anywhere. This isn't so. These mill-type lamps are designed for strength and in obtaining this strength the manufacturers have had to sacrifice efficiency. For example, a 50-watt Mazda B mill-type lamp gives 420 lumens or light units, whereas a 50-watt "regular" Mazda B lamp supplies 500 or an increase of 19 per cent! Then, too, the mill-type lamp costs more than the "regular" lamp.

The mill-type lamp is, of course, far more efficient than the carbon lamp, and is excellent in its place, but it is a mistake to use it where lamps of the regular construction will serve as well, or where local lights mounted on a vibrating machine can be readily replaced with an overhead lighting system, or where it is practical to provide a solid foundation for the machines which vibrate, and thus solve the lighting problem. Look around your plant to see if the right lamps are being used in the right places.

Practical Pete

# Motor and Starter Troubles–

## *Diagnosis and Remedies*

Compiled by H. E. STAFFORD
*Electrical Engineer,*
*Provincial Paper Mills,*
*Port Arthur, Ont.*

| Symptom | Trouble | Cause | Remedy |
|---|---|---|---|
| 1 Motor will not start although it is known there is nothing wrong with the motor itself. | (*a*) Motor cannot develop sufficient torque. | Voltage too low. | Raise the taps on compensator to next higher or even greater if necessary. |
| | (*b*) Motor trying to run single-phase. | One fuse blown or open circuit in one overload relay. | Replace fuse.<br>Replace open-circuited relay which will probably be burned out. |
| 2 Motor starts too quickly. | Motor developing too much torque. | (*a*) Taps too high.<br>(*b*) One or more compensator coils short circuited. | Lower taps.<br>Replace coil or coils with new ones. |
| 3 Compensator issues a buzzing sound. | (*a*) Laminations loose. | Vibration or rough handling. | Tighten bolts holding lamination framework or wedge between coil and laminations. |
| | (*b*) Grounds. | Moisture or rough handling. | Insulate coil from ground, or in most cases insert a new coil. |
| 4 A peculiar rumbling noise issues from compensator oil tank. | Contacts arcing. | Contacts making poor connection. | Press contacts together after properly cleaning and polishing, or renew if badly pitted. |
| 5 Heating of oil tank. | Water in oil. | Water in oil. | Change oil as soon as noticed. If oil is not changed the compensator coils will soon burn out, as the water provides a path for the current even when the coils are cut out of circuit. |
| 6 Explosions occur in starter with the result that flames and smoke issue from the case. One or more fuses will usually blow when this occurs. | (*a*) Contacts arcing. | Loose contacts. | Repair or replace contacts. |
| | (*b*) Switch mechanism or contacts grounded. | Water in oil and mechanism. | Locate ground, which will usually be denoted by the charred appearance of the fiber on the operating bars. Either reinsulate the bar or replace with a new one. |
| | (*c*) Short circuit between contacts. | Caused by water in oil making a path for the current which in time will heat and carbonize the contact bar whether of wood or fiber-covered steel. | Scrape out all traces of carbon and reinsulate if of fiber or renew if necessary.<br>If operating bar is of wood scraping out the carbon and revarnishing the bar is usually all that is necessary.<br>Note: It is best to renew the oil in all three of the above cases. |
| 7 Plunger of no-voltage coil does not operate. | No-voltage coil burned out or disconnected. | Moisture or rough handling.<br>Note: If the plunger or core of a no-voltage coil is removed, the coil will soon burn out. | Repair broken connections or replace burned-out coil. |
| 8 Handle of starter does not stay in running position even when motor is not overloaded. | (*a*) Hammering of no-voltage coil plunger. | Loose contact between overload and no-voltage relays. | Adjust contacts. |
| | (*b*) Overload relays set too low. | (*b*$^1$) Overload relay plunger stuck or shifted. | Adjust either overload or time setting. |
| | | (*b*$^2$) Oil in dash pots too thin. | Use thicker grade of oil. |

*Note*—Starters should be thoroughly inspected at least once a month and where the motor is started and stopped frequently, the starter should be inspected every two weeks.

## Things to Watch on Induction Motors

| Time of Inspection | PART INSPECTED | | | | | |
|---|---|---|---|---|---|---|
| | Bearings | Motor Frame | Motor Windings | Rotor | Starter | Switches and Fuses |
| Daily | Oil if necessary.<br>See that rings are working.<br>Feel for rise in temperature. | Examine ground wire. | Feel for excess heating. | See if there is proper end play. | If in a damp place, feel the oil tank. If hot, it denotes the presence of water in the oil. | |
| Weekly | Examine oil and renew if gritty or darker in color than usual. | Adjust end bells to center the rotor. | Blow out winding with compressed air or hand bellows if motor is in a dusty place. | Use feeler between rotor and stator to find if rotor is out of center. | Overhaul starter if motor is started and stopped frequently. | Inspect. Clean if necessary. |
| Monthly | Renew oil on all high-speed motors and all others situated in dusty locations. | | | | Overhaul starters. | Inspect and clean. |
| Every four months | Bearings should be drained and cleaned with kerosene and oil renewed.<br>High-speed sleeve bearings should be carefully examined and in most cases renewed.<br>Ball bearings should be cleaned and greased. | | If windings are subjected to corrosive elements, motor should be thoroughly cleaned and baked, windings revarnished, and again baked. | Rotor should be cleaned and if it is a wound rotor should be treated same as stator. | | |
| Yearly | Renew all bearings | Frame should be cleaned with kerosene. | All windings should be cleaned, varnished and baked. | Rotor overhauled. | Oil should be changed in all starters. | Switch and fuse contacts should be renewed if badly pitted. |

**IN MAKING COILS for motors, as in all other work, experience plays a big part in getting good results. Through actually making many coils, better methods are discovered. Through watching repair operations the advantages of these methods are judged. In this article Mr. Roe, who is shop superintendent of the Detroit Service Department of the Westinghouse Electric and Manufacturing Company, gives some details of coil-making methods which have been found to be economical and to give satisfactory results and long operating life of coils. These details supplement the information on diagrams for coil winders published in the June issue of the INDUSTRIAL ENGINEER, page 283.**

## *A. C. ROE Gives Shop Practice and*

# Details of Coil-Making Methods

## *For Coils Used for Different Windings and Voltages*

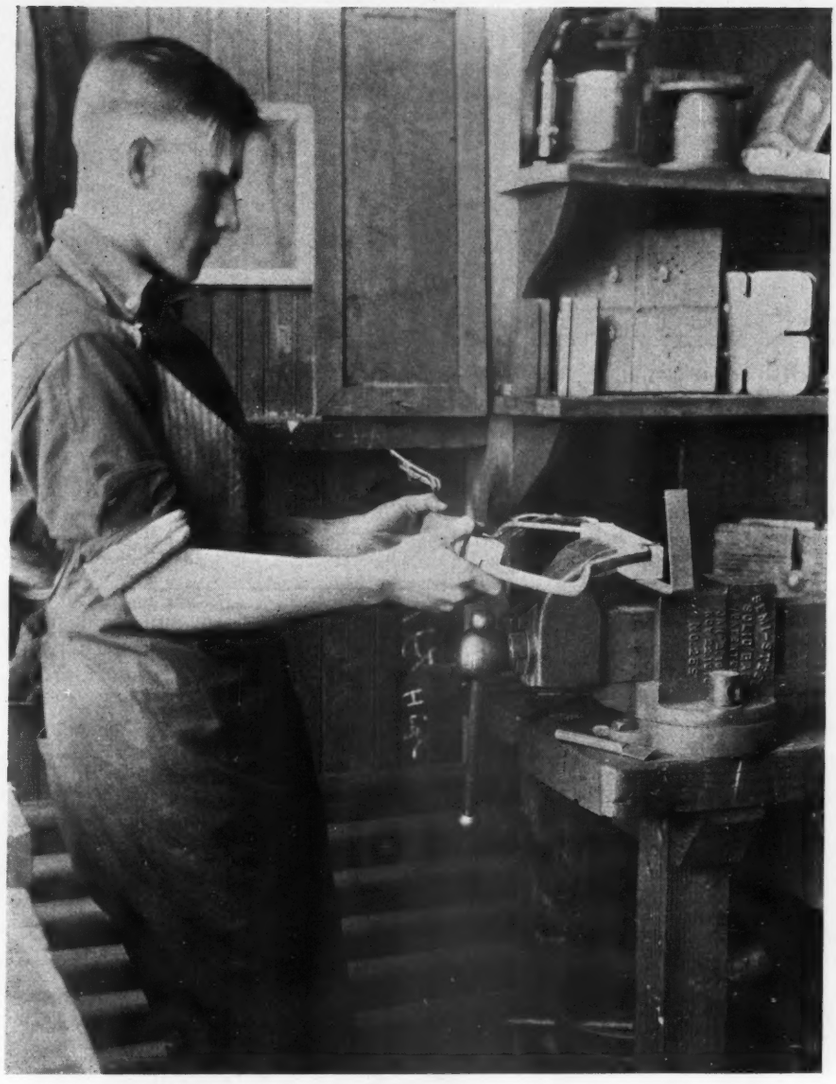


*Fig. 1—The coil winder is shown here pulling a coil to the required shape in a bench vise by the use of hand blocks.*

IN THE article on making up diagrams for coil winders published in the June issue, general information and data that should be available when making different kinds of coils was given. In this article additional information is presented on winding particular types of coils. This information is arranged under the names of the various coils that are used in motor windings.

*Mush Coil (M)*—A mush coil such as is used in induction motors having one coil per slot or a basket winding can be made on a mold like that shown in *A* (Fig. 2). The slot sections of the coil are of different lengths and the leads are brought out on the long side. The mold is simple to make, and the two outside pieces, *a* and *c*, can be used for other centerpieces than *b*, which is fastened to *a* with six screws. The thickness of the centerpiece is determined by the height of the motor slot, the other dimensions being obtained from a sample coil removed from the motor to be rewound. The piece *a* is fastened to the winding machine, and *b* is held in place by a wing nut. The two pieces of ¾-in. friction tape that hold the coil together are put in the slots cut in the mold ends underneath the first turn. The starting leads are put through the slots *d*. The parts of the centerpiece of the mold under the binding tape should be tapered slightly toward the front so that the finished coil can be removed easily. Double-cotton-covered wire should be used for this type of coil. At *G* of Fig. 7 is another mush coil.

Coil *a* (Fig. 2-B) is another mush coil of the two-layer type of winding. The leads for this type are brought out at the diamond point and the coil is held together with cord. Single-cotton-covered enameled wire is used for these coils. A similar coil is shown at *H* of Fig. 7.

*Bip*—An easily made type of coil is illustrated in (Fig. 2) at *c*, *e* and *f*. These coils (Bip and Bip-B) are flat-mush-wound. They are taped with 0.004-in. by ¾-in. cotton tape applied not too tightly, so that the armature winder can shape them to fit the slots and ends without crushing the insulation. The tape should be just tight enough to allow the wires to roll easily. At *e* is a coil (Bip) used for open-slot bipolar armatures. At *f* is a coil (Bip-B) which differs from *e* in that the slot section is not taped. The coil is used for partly closed slots or where the slot room is scarce. At *c* is a flat diamond mush coil, which replaced the original winding of diamond pulled insulated coil. As the cross-section of the original coil was very

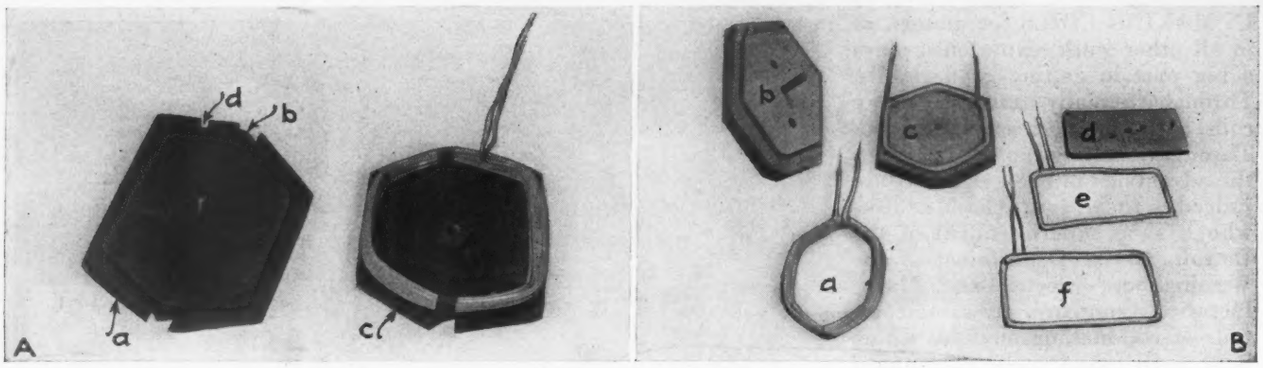



**Fig. 2—Mush coils which are not wound in layers.**

*A*—One-layer coil for basket windings of induction motors and form on which it is wound. A similar coil is shown in *H* of Fig. 7. *B*—Coils for two-layer windings. At *a* is a diamond mush coil. At *G* of Fig. 7 is another coil of the same type. At *c* and *e* are Bip coils, while at *f* is a Bip-B coil of which the slot section is not taped.

nearly square and it was wound with No. 16 double-cotton wire, which is small, in layers of twelve turns of two wires, four deep and three wide, it was decided to substitute a mush coil using single-cotton-covered enameled wire and putting the required insulation in the slot while winding the armature, after which the entire armature was dipped.

Considerable time and money can be saved by such substitution, as there are numerous coils which are pulled and wound in layers and insulated that could be safely and easily wound flat-mush at much less expense. In fact, any low-voltage coil, for 110 volts or 220 volts, not greater in cross-section than ½ in. either way, not high and narrow, and wound with No. 15 or smaller wire, can safely be made a flat-mush (Bip) coil by using single-cotton-covered enameled wire and putting sufficient insulation in the slots. Colored sleeving can be applied while winding. When more than one color of sleeving is required, each color can be put on the starting lead and the finishing lead of the same coil, making it unnecessary to light out the leads when connecting the armature.

*C-W*—Another type of coil *(C-W)*, which may be used on low-voltage alternating-current or direct-current windings, where insulation can be applied to the slots while winding. was described in the former article. This type of coil is in the same class as the flat-mush coil, being safe, quick, simple and cheap and requiring only one dipping. It is of the same shape as the threaded puller coils except that the coil is taped loosely all over instead of being held together with cord.

*Mush Puller (M-P)*—Mush-puller coils *(M-P)* are used in the two-layer type of winding in partly closed or open slots in place of the mush coil when the size of the wire and turns required would make a mush coil stiff and hard to form when placing in the motor. These coils are wound with double-cotton-

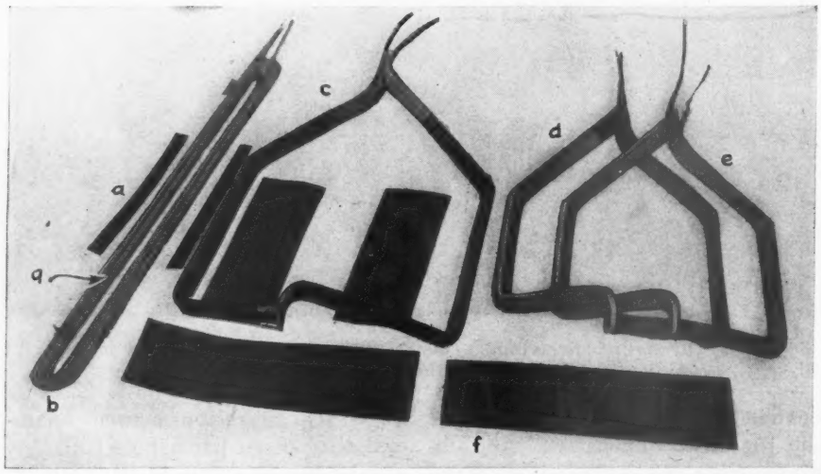



**Fig. 3—Insulated puller coil.**

Wound on a shuttle and stiffened with shellacked fullerboard strip *a* between layers of coil as at *g*. In *E* of Fig. 7 and in Fig. 8 are other coils of this kind. If the coil is single-layer, paper is wrapped around the cell section instead of inserting the fullerboard (see *B* of Fig. 6). After the coil is stiffened (by either method) the entire coil is taped with cotton tape. At *d* is shown a phase coil which has been painted red at the lead end.

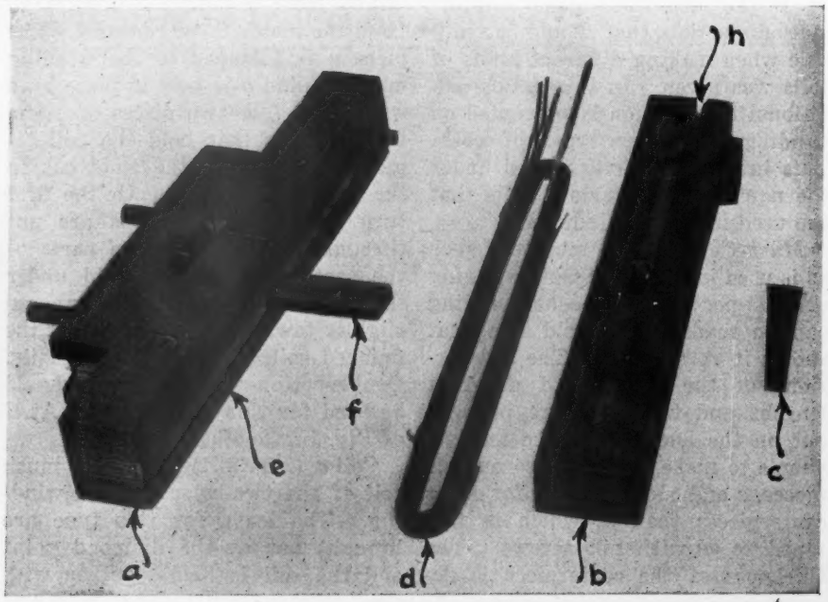



**Fig. 4—A shuttle for winding loops for puller coils.**

This shuttle is mounted on a winding machine. The top piece *b* fits over the bottom piece *a* and is held firmly in place by the key *c*.

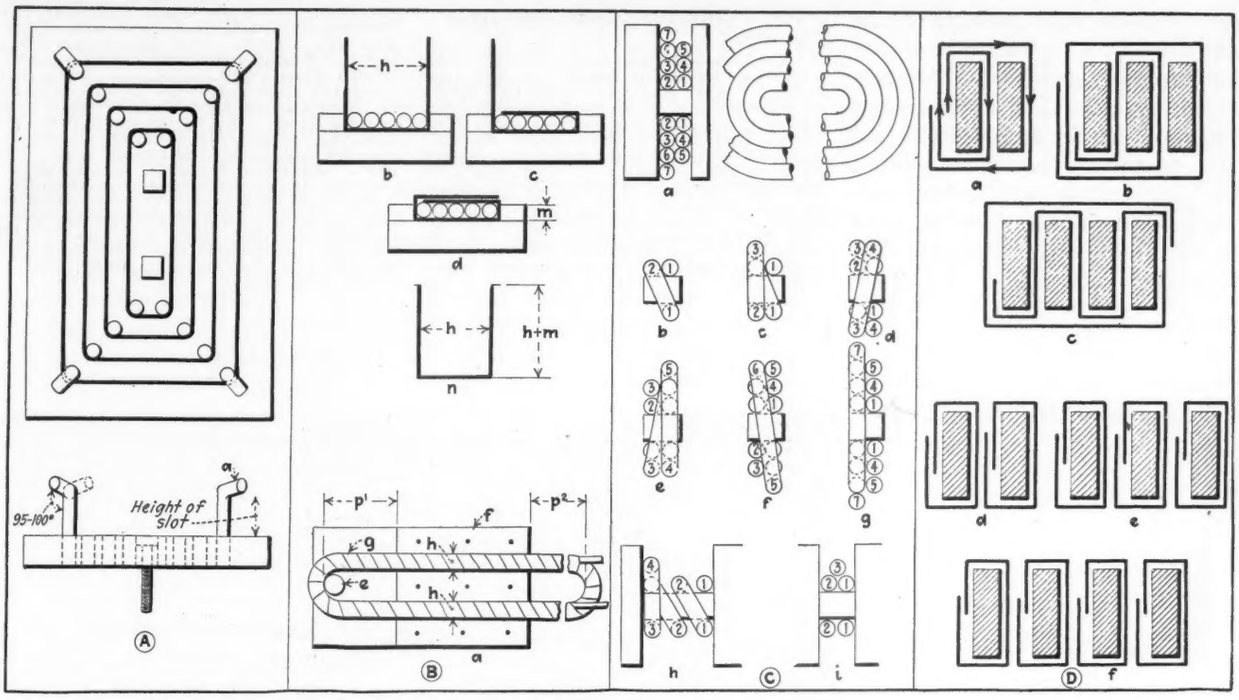



**Fig. 6—Details of laying out, winding and insulating various kinds of coils.**

*A*—Method of laying out a board for winding a concentric mush coil. *B*—Applying insulation between turns of layer-wound coils or on single-layer coils. *C*—Winding a cross-over coil of seven turns. See also Fig. 9. *D*—Applying insulation to strap-wound coils. See also Fig. 9.

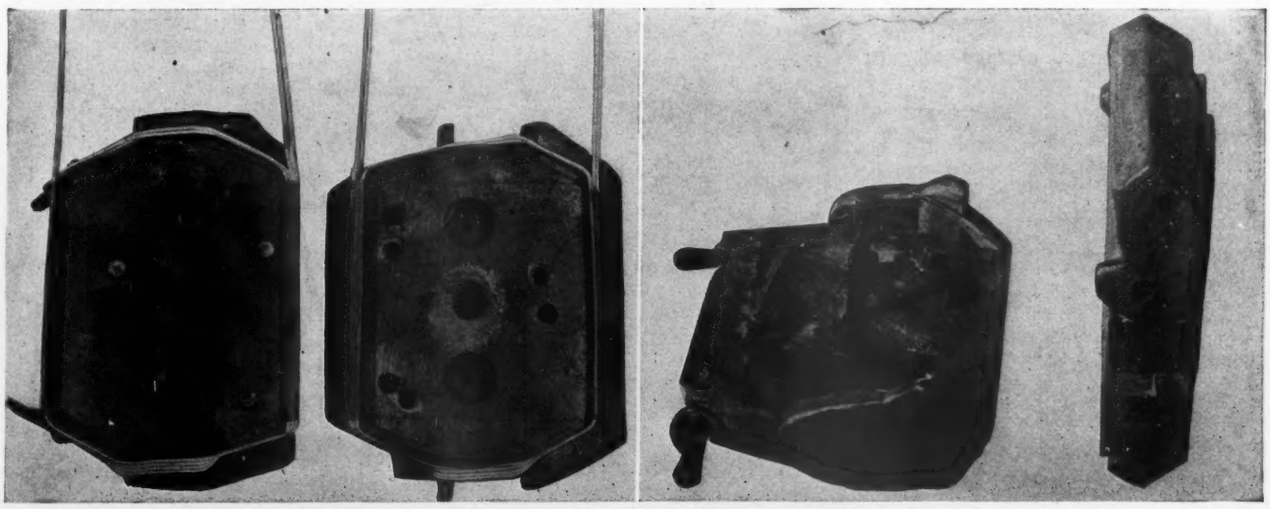
covered wire in sizes No. 14 and larger and with single-cotton-covered enameled wire for No. 15 and smaller. In Fig 4 is shown the shuttle on which the mush-puller coils are wound. The coil, however, is not a mush coil, as the wires are wound in layers, while in the mush coil they are wound as they fall, as shown in Fig. 2. The piece *a* of the shuttle shown in Fig. 4 is fastened to the winding machine and the fiber centerpiece at *e* is fastened on *a* with screws. It is 1/16 in. less in thickness than the width of the motor slot and ⅜ in. wide. Two ⅜-in. fiber dowel pins are placed at each end of the centerpiece as shown, one being cut off flush, while the lead-end pin is allowed to project ¾ in. into the top piece *b*. To prevent this piece from rocking, it is held in place by the key *c*, which fits into the slot in the clamp *f*. This key is put in and knocked out with a light tap from a mallet and is much quicker than thumb or wing nuts. At *h* is the slot cut to allow the starting lead to be placed out of the way, so that it will not interfere with the rest of the turns as they are wound around the pins. After winding, these coils are pulled to shape in a pulling machine (Fig. 8) or by hand (Fig. 1).

**Fig. 5—Molds for winding coils of special shape.**

The body of the mold is of wood while the wearing surfaces are of hard fiber.

*Concentric Mush (C-M)*—Concentric mush coils *(C-M)* are used in the stator windings of single-phase repulsion motors. This type of coil usually requires a number of different sized coils and molds. A simple way to make up such a set of coils is to lay out a 1-in. board as shown at *A* (Fig. 6). Two bolts are placed in the center, so the board can be fastened to the winding machine. Then lay out on the surface of the board, in pencil, the sizes of the coils and drill holes at the four corners of each coil layout. Bend four pieces of ¼-in. round stock, thread one end and put these pins successively in the different holes.

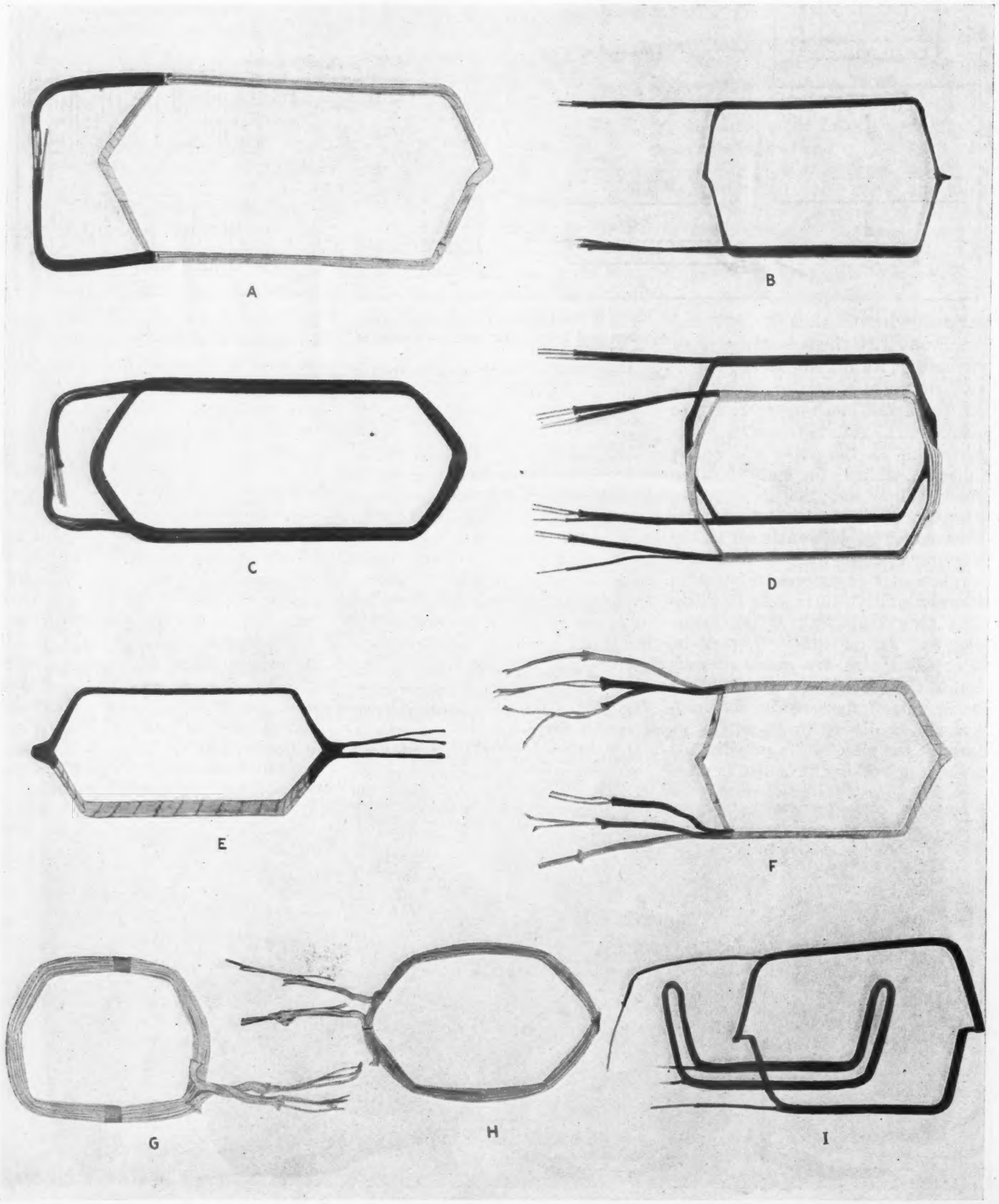
*Threaded-in Puller (T-P)*—Thread-



ed-in diamond puller coils *(T-P)*, as shown in Fig. 9, are made on the shuttle already described. This type of coil is wound with a gum-treated wire that is tacky and holds the coil in shape while winding and pulling. The slot sections of the coils are powdered with soapstone to make the wires slide over the treated-cloth cells. This wire saves considerable

**Fig. 7—Different shapes and types of coils.**

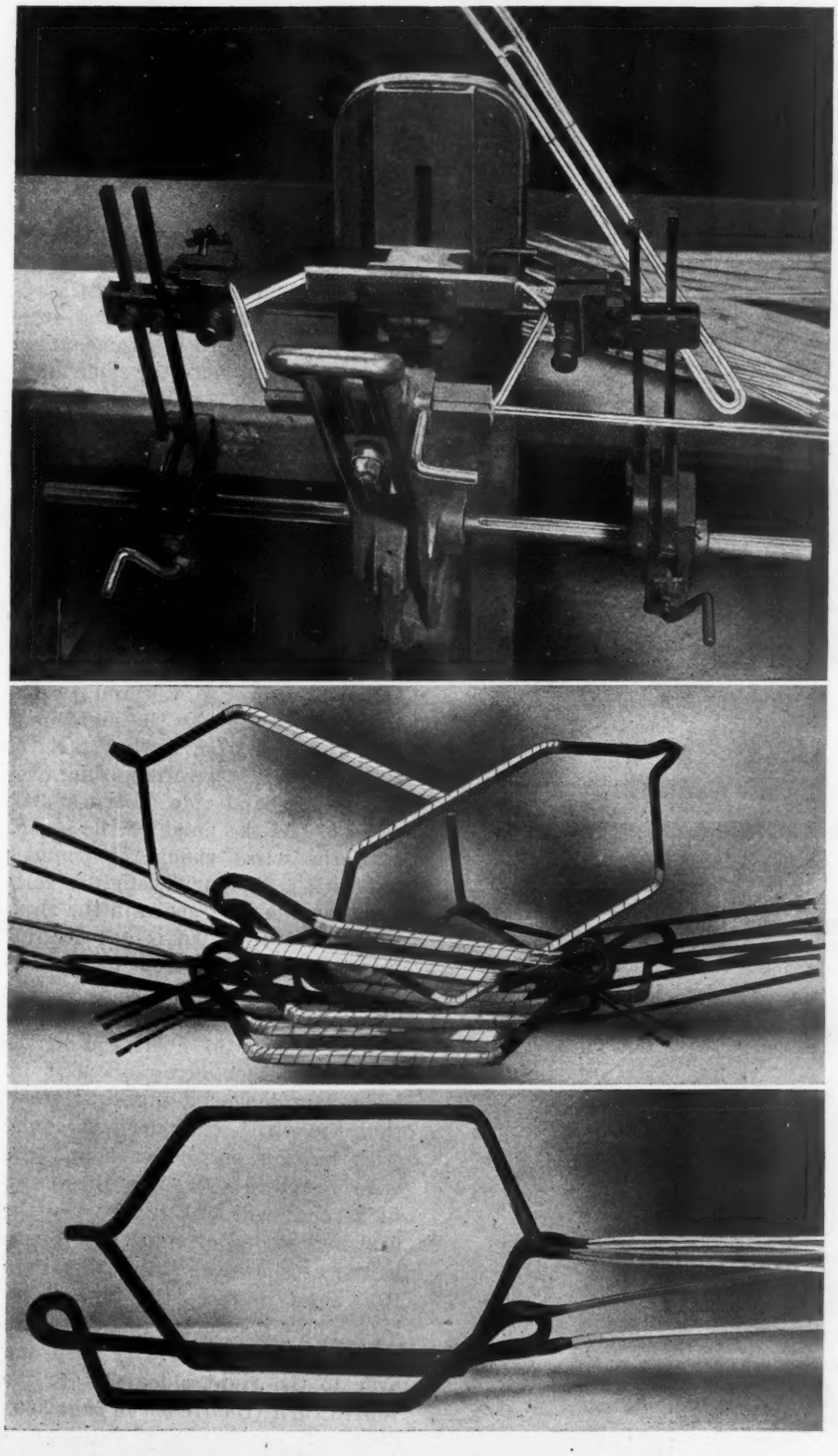
*A*—Mold-wound armature coil wound with six wires in hand. It has two turns. For stiffening the coil, two strips of fiber covered with shellac are put between turns along the cell sections. The coil is then heated, after which the cell sections are pressed to shape, which will be retained by the stiffening effect of the shellac. *B*—Two-turn mold-wound railway armature coil. *C*—Mold-wound armature coils. *D*—Mold-wound coils of the "broken-back" type. One of the coils has been wound and Bearon paper glued around the cell sections, after which they are pressed to shape. The other coil, after the same treatment, has been taped (varnished cambric and cotton) and dipped. *E*—A pulled coil for a stator. It was taped (with turns spaced apart), dipped and pulled hot. Then it is insulated with varnished cambric on the cell section and taped, after which it is again dipped. *F*—A direct-current pulled armature coil. Note three colors of sleeving. *G*—A diamond mush stator coil for a one-layer winding. *H*—A mush-wound coil for a two-layer winding often used for small stators. It is wound with single - cotton - covered enameled wire. *I*—Involute coil. This coil was wound on a flat board with pegs at the corners of the coil. It was then spread out to shape and taped.



time on a job, as the coils do not have to be dipped before use. The four single cords on the coils shown in Fig. 4 and Fig. 9 are put on through the slots of the shuttle while winding. These slots must be deep enough to allow the cord to sink in and not interfere with the wire. For all coils wound in layers, the fiber centerpiece should be the exact width of the coil to be wound.

*Insulated Puller (P-C-A)* — The coils shown in Fig. 3 and Fig. 7 are wound on a shuttle, shown in Fig. 4, and pulled to shape. This type of coil is wound with untreated round or square double-cotton-covered wire. As the coils are insulated completely before assembling on the motor, some means of holding the slot section rigid must be provided. One method applied to coils wound in more than one layer is to use 0.007-in. shellacked fullerboard. Such fullerboard has been dipped twice in shellac and air-dried between dips. The fullerboard is cut into strips of the required length and width, and these strips are placed between the layers of the coil as shown at *g* in Fig. 3 and on the mold-wound coil in Fig. 7. Care must be taken that the wires are not crossed while inserting the strips, which are tied in place with two turns of a light flax at each end. The loop (the term used for a shuttle-wound coil before it is pulled), with the strips in place, is then put in a small oven and heated until the shellac becomes tacky, which is usually about two minutes, after which it is put into a cold press and allowed to cool one or two minutes. One man can press from sixty to a hundred coils an hour. If a cold press is not available and the coils do not fit too tightly in the motor slots, they can be pulled to shape immediately. After they are removed from the oven they may be taped immediately with 0.004-in. cotton tape applied tightly while holding all wires in position, not allowing them to cross or bulge. When the shellac cools, it will hold the wires in shape.

**Fig. 8—Three steps in the making of an insulated puller coil.**



For single-layer coils, as *c* in Fig. 3, or multiple-layer coils where the room taken by the fullerboard strips would be too great, a 0.003-in. "Bearon" paper cell may be used for coils wound with No. 11 and smaller wire. For coils wound with No. 10 and larger wires, 0.005-in. cells are employed. Fig. 6-B shows the method of applying this binding cell. The paper is cut the full length of the longest slot section and the width of the paper is three times the width of the layer as shown at *b*, plus two times the thickness of the layer as shown at *d*. For this purpose a block is made of a 1-in. wood base, on which are three fiber strips the same length as the paper cells and the same thickness as each layer *m*. The centerpiece is as wide as the pin used on the shuttle, and the outside pieces are nailed in place, leaving two channels into which the coil and the paper cell fit snugly. The pin *e* acts as a gauge to make all cells equidistant from each end of the loop.

The paper cells are creased as at *n*, and hot fish glue is applied to the bottom of each channel thus formed, two cells being glued and placed between the fiber strips on the block. The coil is next placed over the papers and forced down into place with a wooden mallet as at *b;* then hot

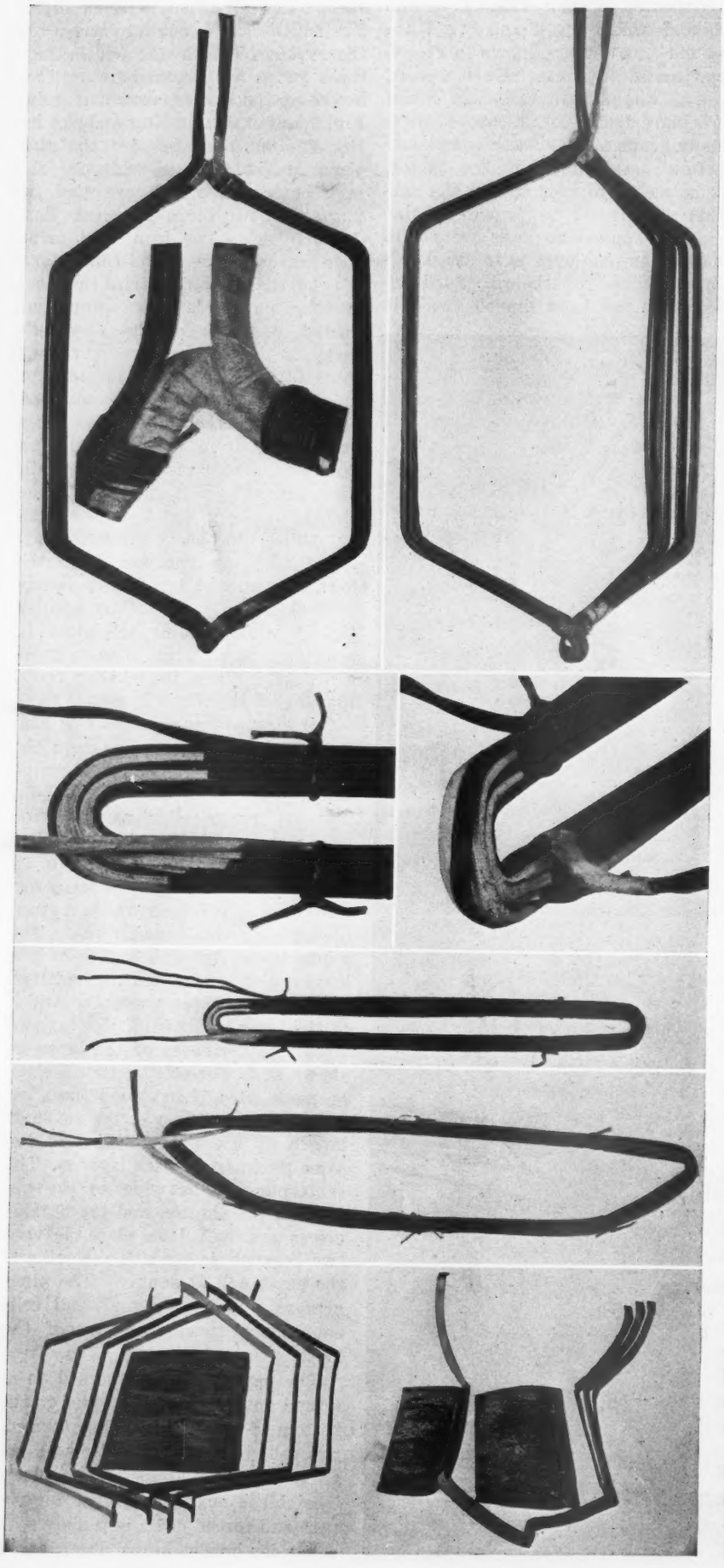


**Fig. 9—Detail views of puller and strap-copper coils.**

The top illustration shows a threaded-puller. At the right one cell section is spread apart to show how it is threaded into a partly closed slot. The close-up view explains how the leads and diamond-point are taped and tied. The central pictures are of loops wound on a shuttle. They are to be pulled to shape. At the top is a cross-over coil while the close-up views show how tape is applied to alternate layers at the cross-over point. The method of winding a cross-over coil is explained in *C* of Fig. 6. Below is a "fish" type of loop wound on an unsymmetrical shuttle. The bottom picture illustrates the manner of insulating strap-copper coils. This is also shown in *D* of Fig. 6.

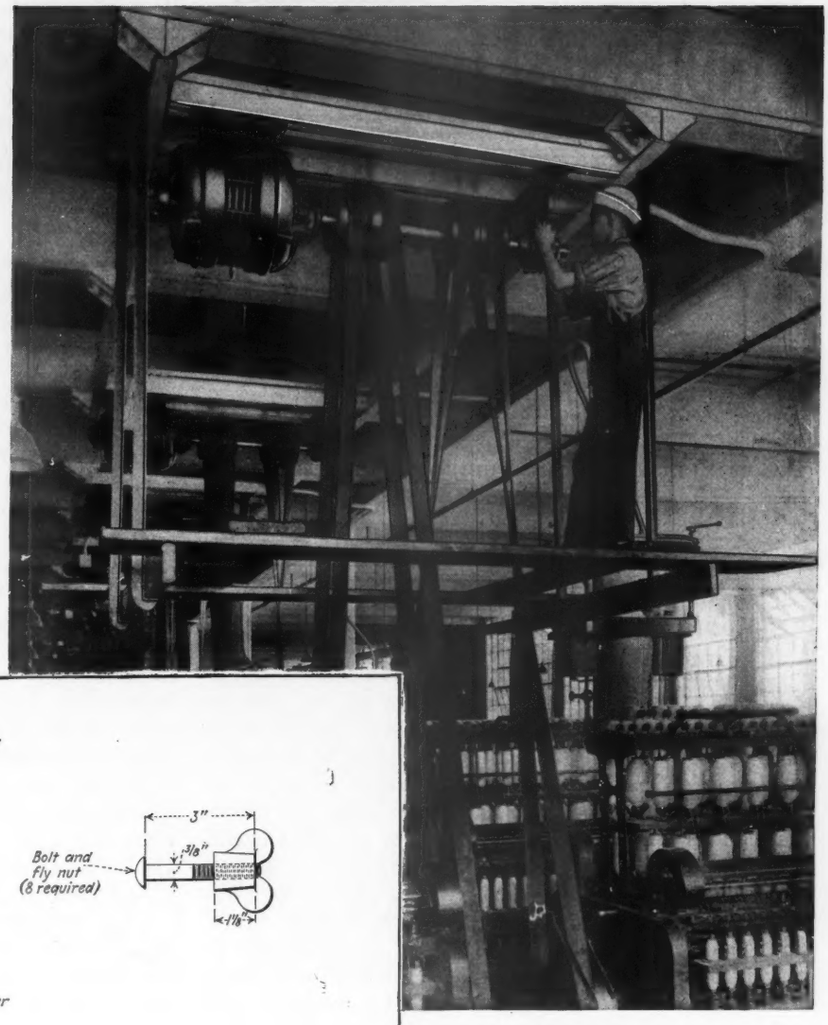
glue is applied to the parts of the cell above the block. Next each side of the cell is folded over the coil and tied in place. From twenty to forty loops per hour can be covered.

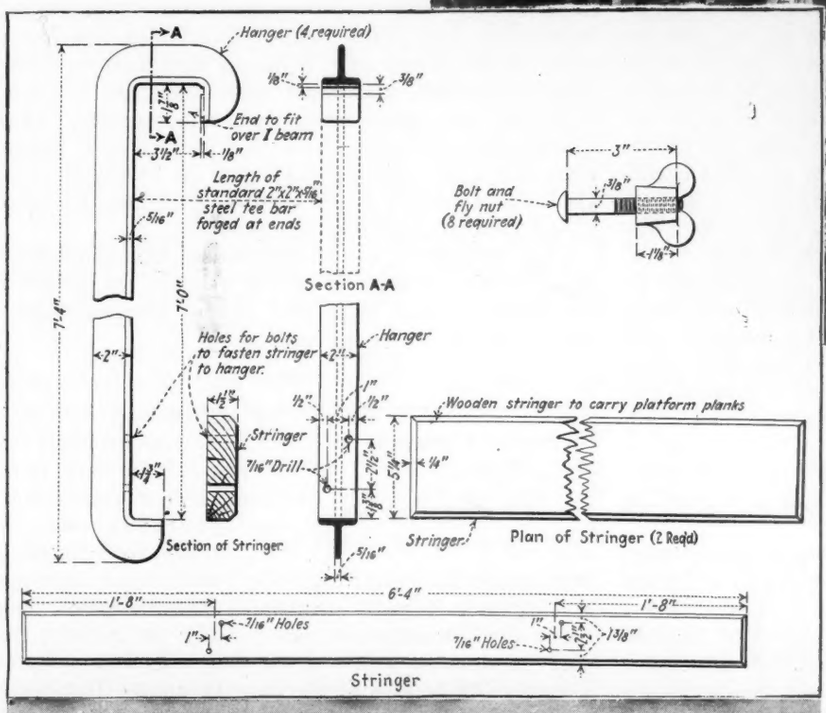
The loop shown at *b* in Fig. 3 is an odd-turn cross-over coil. It is wound with one wire in hand, in seven turns, and two wires wide by four deep per coil. As there are only seven turns, one side of the coil would be three deep and the other side four deep. To overcome this, a piece of mason's cord the same diameter as the wire is put in the smaller side. The term "cross-over" coil is used to designate a coil wound with one wire in hand (or one reel of wire) and more than one wire wide in the shuttle. The winding of cross-over coils is illustrated in *C* (Fig. 6). As shown at *a*, the wire space in the shuttle is just wide enough for two wires. The successive steps in putting on seven turns are given in *b*, *c*, *d*, *e*, *f* and *g*. The first turn is kept to the right-hand side of the shuttle, and to start the second turn the wire is sprung over to the left-hand side of the shuttle as at *b*. At the finish of the second turn the wires should be pounded flat with a fiber drift, slightly thinner than the wire space in the shuttle. The third turn is put on over the second turn and kept to the left-hand side of the shuttle as at *c*. The wire should be held over the top of 2 with a piece of fiber held in the hand, this fiber being about 1 in. wide. 4 in. long and slightly thinner than the wire. If the coil is wound with tension on the wire and the wire not held over, the third and fifth turns will sink in between the first and second or third and fourth turns, as shown at *i*, in which case it is hard to force the fallen wire back where it belongs. At the finish of the third turn, the wire is sprung over to the right side to start the fourth turn (*Continued on page* 360)

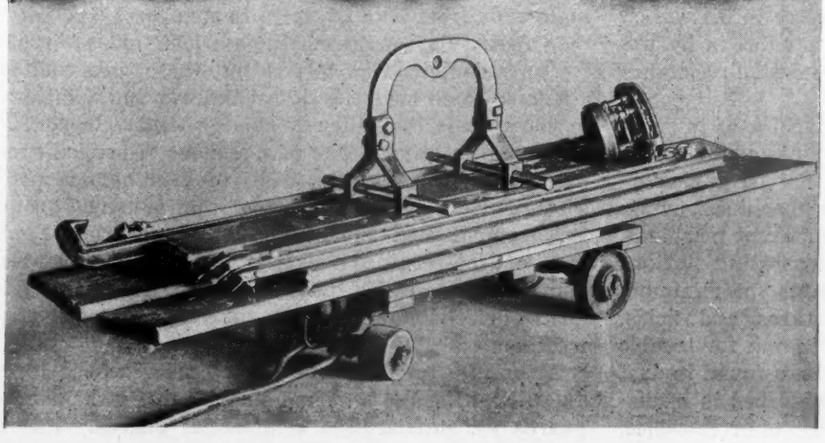
*A Knockdown Scaffold for*

# Mounting Equipment on Ceilings

## *Inspecting Motors and Making Quick Changes in Layouts*





REPAIRMEN who have worked with their hands raised above their heads while standing on a shaky stepladder will appreciate the comfort and safety of the knockdown scaffold shown in these pictures. It was built to assist in handling motor and drive equipment mounted near the ceiling and for use by repairmen when installing equipment or making inspections or adjustments.

This frame is made to hang from channel-iron motor supports in the plant of the Naumkeag Steam Cotton Company, Salem, Mass. When it is to be moved from one location to another it is placed on the small hand truck as shown in the bottom illustration. It can be easily put up by one man. The four hangers are made of standard steel T-bars, with one end forged into a kind of hook to fit over the motor support and the lower end bent to accommodate the edge of the stringer. When the hangers and stringers are in place planks are used as a platform.

# INDUSTRIAL ENGINEER

*Devoted to the Maintenance and Operation of Electrical and Associated Mechanical Systems in Mills and Factories*

DANIEL H. BRAYMER
*Editorial Director*

*Assisted by*
G. A. VAN BRUNT E. H. HUBERT F. E. GOODING

Chicago, July, 1922


### *What Insulation Resistance Tests Do You Make?*

MAINTENANCE men who have had considerable experience in the handling of electrical equipment have at one time or another been forced to do more or less guessing about the condition of electrical insulation of machines that are operated in moist atmosphere or have stood idle for a time under conditions that call for a decision as to whether or not they should be given a baking test to prevent grounds or insulation breakdown at the wrong time. Then, again, there are those who have had less experience with these conditions and show a tendency to condemn the apparatus as poor in quality when troubles from grounds and flashovers from surface leakage through oil, metallic dust and dirt occur. It is truly remarkable that more troubles of this sort do not occur, and this is marked evidence of the very high quality of modern insulating materials. But from the standpoint of conserving investment and preventing troubles, ignorance or indifference regarding the insulation resistance of machine windings cannot be excused.

Every maintenance department should be equipped with some method of testing the condition of windings and machine circuits operated at 440 volts and above, and it should be the job of some one individual to know something about the subject of insulation resistance and insulating materials best suited for the conditions under which electrical apparatus operates in his works. One of the best ways to make such studies is by use of the megger and curve records of insulation resistance made up at regular intervals.

In determining the condition of a machine as to moisture it is important to have relative values of insulation resistance in the same winding and not be guided by relative values of windings of other machines, owing to the variations of these values in different machines. Some companies that operate large generating stations near tidewater have set one megohm as the minimum safe insulation resistance of armatures and fields. When the value is lower than this, a search for trouble is started and the weak spot is sometimes found in dust and dirt on relay contacts, moisture absorbed in insulation of the wiring to controlling rheostats or in cables. It is important that the test should be made on the complete unit and on its individual parts, for only in this way can troubles be located and removed.

### *Simplification of Pulley Sizes for Motors*

SINCE the publication of the report of the Committee on the Elimination of Waste in Industry created by Herbert Hoover, some new and effective thinking has been directed toward simplification of processes, the elimination of commercially non-essential types, sizes and styles of materials and parts that are carried in stock. One interesting development to industrial engineers is the study being made to simplify pulley sizes for motors and other purposes. The Electric Power Club has already done quite a bit in this direction and has included in its handbook recommendations for standard pulley dimensions such as diameter, bore and pulley belt width for different ratings and speeds.

In view of the present interest in this matter on the part of the pulley manufacturers and the fabricated production department of the Chamber of Commerce of the United States, industrial engineers should become familiar with the recommendations of the Electric Power Club and similar standardization movements, in order to effectively aid in placing before these bodies suggestions that will lead toward simplification along lines that have given most concern in the past. Shaft dimensions, extension sizes for pulleys and keyway sizes are good points to consider in this connection. On these points the Electric Power Club has also established recommendations for motors.

This publication will be glad to see that communications on this subject from our readers are placed in the hands of those interested, if they are addressed to the attention of the editor.

### *Safety Congress at Detroit Aug. 28 to Sept. 1*

THERE are two kinds of safety, as Practical Pete points out in this issue: safeguarding machines and safeguarding men. In many cases the solution of one is also the solution of the other, or at least goes a long way toward decreasing the hazard. Those especially interested in safety work in industry will pick up valuable points at the Eleventh Annual Safety Congress, to be held at the Cass Technical High School in Detroit from August 28 to September 1. A particular feature of these meetings which makes it easy for an industrial man to pick out those talks and discussions which have the closest bearing and application to his work is the policy of holding them. In addition to general meetings, each of a number of section group meetings will take up the safety problem as it is met in a particular industry. A few of the industrial groups, for example, are: rubber, textile, woodworking, automotive, drop-forging, metals, educational, health, steam and electric railways, public utilities, and others. Industrial electrical hazards are taken up in special group meetings.

Among the topics of interest to readers of the INDUSTRIAL ENGINEER is a debate on the value of home-made guards *vs.* standardized commercial guards. Factory

housekeeping is another subject discussed at one of the general meetings. In addition, all will be interested in the exhibit of industrial safety appliances. Arrangements are being made to secure a special rate of a fare and a half for the round trip. Complete details may be obtained from the National Safety Council, 166 North Michigan Boulevard, Chicago, Ill.

### *When a Stitch in Time Saves Nine*

NO successful plan has yet been devised to eliminate natural wear and tear on electrical or other apparatus in regular service, although there are wide variations in its reduction, depending upon the attention that is paid to those parts where it is most severe. With plants now going back to normal operating schedules, it is important from the standpoint of economy and continuity of production to make sure that a revised and nearer normal stock of spare parts and supplies is carried in the stock room. In most cases this stock has been drawn down to a minimum, owing to part-time operation and the need to reduce it accordingly, with the result that an emergency repair or change in machine layout may be most expensive.

In one plant it was normally the practice to carry about $700 repair parts for a 5-ton electric hoist outfit on the basis that the interest on the investment at 6 per cent was a small part of the actual loss that might result if the equipment was disabled for a single day. This is just one example of how this kind of thinking and the spending of a small amount in adequate parts to care for natural wear and tear will show good dividends over the period of a year and help the maintenance department to prove its importance in reducing the cost of production by cutting down the idle time of machines and the men who operate them.

# Concerning Our Name

INDUSTRIAL ENGINEER—*Devoted to the Maintenance and Operation of Electrical and Associated Mechanical Systems*

BEGINNING with this issue the name of this publication will be INDUSTRIAL ENGINEER. This change does not carry any modification of the editorial policy but makes it possible through the name to more definitely indicate the editorial scope of this journal. It will continue as it has during the past six issues as a new series of the *Electrical Review* established in 1882.

In the outline of editorial plan and scope in the January issue, the writer analyzed in detail the course of engineering thinking of a technical and research character in the growth of industrial works in this country and pointed out the need for more evidences downward throughout works organizations of a similar application of engineering thinking in operating practices and in the maintenance and operation of the systems that are a part of or auxiliary to manufacturing processes from the standpoint of continuity of service and production costs.

Engineering work in industries can be roughly divided three ways: 1. That calling for the technical services of a civil, electrical, mechanical or other professional consultant. 2. That calling for the services of a professional consultant in the analysis or development of industrial processes or phases of management. 3. That calling for the services of men in the operating organization of the works whose training and experience qualify them to be classified among engineers of groups 1 and 2 and also groups of supervisors of work who possess practical experience and ability to interpret the engineering thinking of their engineer executives and the plans of groups 1 and 2, to modify them as conditions demand, to maintain machine production on an economical basis under changing conditions of plant growth or new requirements and to handle work and machines with a view to maintaining continuity of service and controlling production costs.

It is to the Industrial Engineers who make up group 3 that this paper is particularly addressed—those men who represent the execution of engineering thinking in the various departments of an industrial works and carry out in a practical way the ideas and ideals of management in the processes of production.

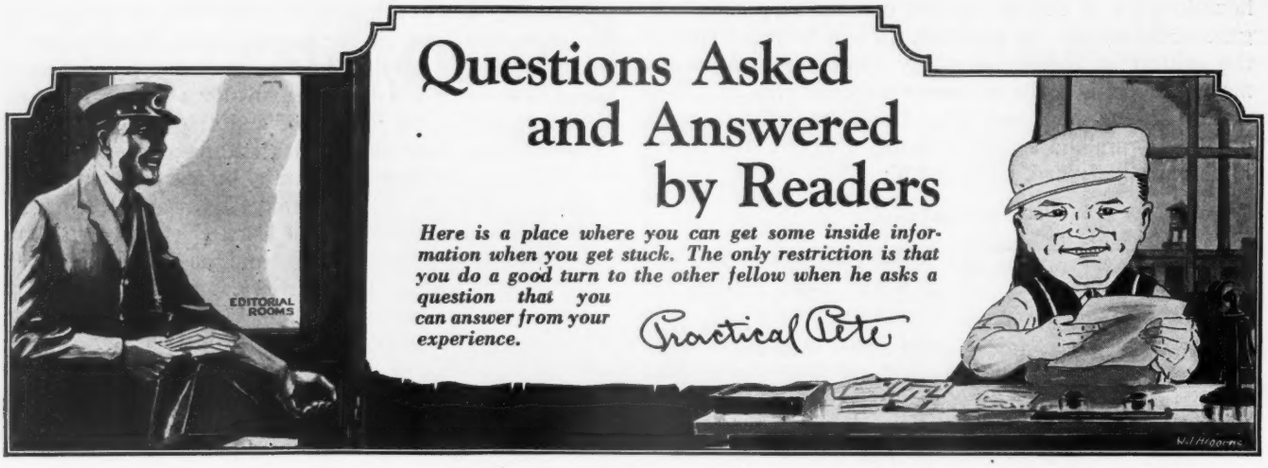
In the past, the work of these men has been in the main a job and we are wrapping this paper around the various phases of that job in such a way as to analyze its practical phases and help them to organize the work on the best lines of engineering practice.

In view of fast growing applications of electric service in industrial works and its close association with the operation of mechanical systems, special editorial consideration is given to details of such service requirements and present practice in meeting them from the viewpoint of the supervising heads responsible for the inspection, overhauling, changing and repairing of the systems involved. In this work both the electrical and mechanical details of the job are discussed. In dealing with any phase of it, a true balance of the practical importance of the electrical and mechanical details will be maintained as controlled by the relationship of the electrical and mechanical features that are associated in the operation of any particular mill or factory system.

In this connection INDUSTRIAL ENGINEER is rendering a new and complete service to a group of men who are doing worth while things and represent a phase of engineering thinking in the operation of American industries that will expand and grow in importance in proportion to the expansion of the physical proportions of industrial works and the added complication of production processes.

Daniel H. Braymer

*Editorial Director, Industrial Engineer.*




# Questions Asked and Answered by Readers

*Here is a place where you can get some inside information when you get stuck. The only restriction is that you do a good turn to the other fellow when he asks a question that you can answer from your experience.*

## Who Can Answer These?

**Calculating a Resistance for a Special Purpose.**—Please outline a method by which I can calculate the space requirements and convenient makeup of a resistance of 270 ohms and 2.27 amp. capacity. I would like to have the method cover both flat and round wire.
Paterson, N. J. M. G.

* * * *

**Changing D. C. Motor to Universal Type.**—Please give diagrams and other information showing how to change the winding of a d. c. motor to one of the Universal type that will operate on both d. c. and a. c. I refer to a small motor about 1/16 hp. rating.
West Reading, Pa. A. J. G.

* * * *

**Motor Starting Trouble.**—The windings of a 150-hp., 440-volt, three-phase, 25-cycle induction motor have been changed for operation at 60 cycles on the same voltage. This motor will not start under load as now connected. Two auto transformers are used, marked 200 hp., 440 volts. Can a change be made in these transformers to increase the starting voltage, so as to start motor under load?
Bellefontaine, Ohio. H. B.

* * * *

**Connections for Motor Brushes.**—The writer would like to know what has been found best practice in fastening the flexible wire (pig tail) on carbon brushes for motors. I would like to see a sketch and an explanation of just how the wire is fastened to the brush.
Racine, Wis. T. G. L.

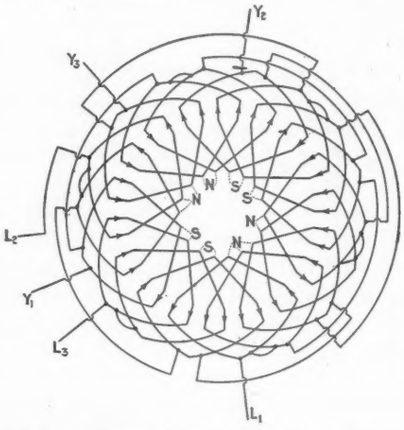
* * * *

**Heating of Low Voltage Release Coil on Compensator.**—We are having trouble with heating of the low-voltage release on a 10-hp. compensator used with a 220-volt a. c. motor. The coil is 3 in. long, 3 in. in diameter with the diameter of core tube 1⅛ in. It has approximately 3,000 turns of No. 27 s. c. enamel magnet wire. The core is made of iron laminations taken from an old transformer, the dimensions of which are as follows: Length, 4¾ in.; diameter, 15/16 in.

The inside diameter of core tube is 1 in. The coil used gets hot after about one hour's operation. We would appreciate it if someone will help us to solve this trouble.
Walsenburg, Colo. E. P. McC.

* * * *

**Is This Motor Connection Correct?**—I should like to know if the accompanying diagram of a motor winding is correct. This is for a three-phase, four-pole, 60-cycle, 36-slot motor with an 18-coil basket winding. If this connection is not correct I should like to see the right one published.
St. Anne de Baupre, Quebec, Canada. E. L.




**Can a three-phase motor be connected like this?**

**Use of Wire Tables.**—In the June number I was interested in the wire tables that were a part of the article on diagrams for winding coils by Mr. Roe, but I do not understand the method of figuring the circular mils from square mils in handling the square wire and ribbon wire. From the formulae I have used the values obtained are greater than those in the tables. I wish someone would explain how to use such formulae in conjunction with the data and tables.
Norwood, Mass. R. E. L.

* * * *

**Armature Insulation.**—What is considered the most serviceable insulation to use for saturating armature coils and the complete winding for automobile generators and starters? Please give information for air drying and baking types of insulation with details for using each.
Homer, La. A. W. T.

## Answers Received To Questions Asked

**Oil on Generator Commutator.**—We are having trouble with oil working onto the commutator of a 16-kw. d. c. generator. The bearing is run with the oil as low as possible, but still a little gets past. I would appreciate details of a method to stop this.
Alta, Canada. W. S.

* * * *

In the June issue of INDUSTRIAL ENGINEER W. S. mentions trouble from oil working onto a commutator. I have had trouble of this kind with a commutator and also with the slip rings of an a. c. generator. In my case the trouble was cured by cutting deep oil grooves in the bearings and drilling holes at the ends of the grooves to allow the oil to run back into the oil well of the bearing housing. I found in the case of the d. c. machine that the oil grooves were very shallow. In the a. c. machine there was no groove in the lower half of the bearing.
Holliston Mills, Norwood, Mass. WM. HARPER.

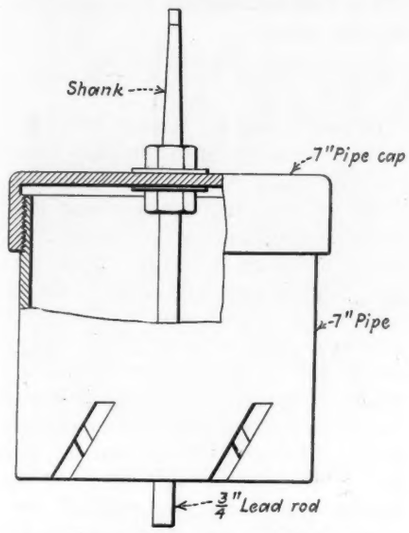
* * * *

**Cutter for Making Large Holes in Switchboard Panels.**—I would like to see a description of a boring device that has been found successful for cutting holes about 4 to 8 in. in diameter in slate switchboard panels.
Quincy, Mass. T. M. C.

We recently made a cutter which may be used for boring large holes in switchboards, that is simple and inexpensive. It is made of 7-in. pipe cut as shown in the accompanying drawing.

We drilled a hole in the center of a 7-in. extra heavy pipe cap and tapped it to take a ¾-in. rod. Then we threaded a ¾-in. rod to screw into this hole and turned the outer end of the rod to a Morse tapered shank. The rod was put in the hole and held by a nut on each side of the cap. Then a piece of extra heavy

7-in. pipe was turned down to the desired diameter and the inside bored to reduce the stock. It was slitted to form cutting edges as shown. This was screwed into the pipe cap.




**A cutter made for drilling 7-in. (diameter) holes in a switchboard.**

The principle advantage of this sand cutter, aside from its low first cost, is that we are able to replace the cutting part when it becomes worn by simply unscrewing it from the cap and putting in a new pipe.

Adrian, Mich. C. A. JOHNSON.

* * * *

**Shifting Brushes of Motor.**—In the case of a 3-hp., d. c., shunt-wound, 220-volt motor that operates at 1,700 r.p.m., by shifting the brushes a little against the speed of rotation about 1,720 r.p.m. can be obtained. Will someone please explain why this causes an increase in speed and if the horsepower of the motor is reduced thereby?

Chicago, Ill. J. A. L.

The following will answer J. A. L.'s question in the June issue on shifting brushes of a motor:

The speed of a d. c. motor depends largely on the counter e. m. f. produced within the windings during operation. When the brushes are shifted back, as in this case, the coils undergoing commutation are under a comparatively active field flux. The volts back-pressure now being produced in these coils would, if the brushes were set at the exact neutral, be added to the total counter e. m. f. of the motor. However, the slight shift has caused the coils to be short-circuited at this point and the effective value of their counter e. m. f. is lost. Consequently, the total back pressure of the motor is lessened and the armature must revolve at a greater rate of speed to make up the deficiency.

The horsepower of the motor is not affected and the process of commutation under load will be better provided the brushes are not shifted too far.

Chicago, Ill. D. F. O'DONNELL.

* * * *

**Rewinding Wave-Wound Armatures.**—We have a wave-wound armature to rewind which has 32 slots and 65 bars with a coil pitch of 1 and 8 and a commutator pitch of 1 and 33. There is one dead coil, making 63 coils in all. Please show how to work up a diagram of coil connections and explain what becomes of the two extra bars.

Detroit, Mich. R. C .A.

I have worked out a diagram which shows how this armature can be rewound and connected. One coil is killed to make the number of active coils fulfill the formula: $C$ equals $[(P \div 2) \times Y] \pm 1$, where C equals the number of coils, $Y$ equals commutator pitch and $P$ equals number of poles. Then, 63 equals $[(4 \div 2) \times 32] - 1$, equals $(2 \times 32 - 1$, equals 64—1, equals 63. To get rid of the two extra bars, they are connected to adjacent bars by a U-shaped piece of copper, the extra bars being 32 bars apart, as the diagram shows. To connect the armature the first coil is put in and the dead coil leads cut off. The bottom lead bar is next located as shown. Then the bars $A$ and $B$ are jumped together by a U-shaped piece of copper the same size as that used in the coils, and the bottom lead of coil 1 is put in bar $B$. This bar should be filled with dummy leads, as there will not be any more leads put in this bar $B$. To locate the other bars connected by a U-shaped jumper, call bar $A$ No. 1 and count over from 1 to 33, which is bar $C$, as indicated. Jump bars $C$ and $D$ together as shown. Note that in each case the jumper goes to the bar ahead of $A$ and $C$, respectively.

The rest of the coils are now put in. The bottom leads of the second coil are put in bars $E$ and $F$. Note that bar $A$ is skipped. No bottom lead is put in it. The remainder of the coils and bottom leads are put down in regular order until bars $C$ and $D$ are reached, then bar $D$ is skipped and $C$ should be filled up, as no more leads will be put in this bar. The rest of the bottom leads are put down, the last lead being put in bar No. 1, leaving two bars to which there is no bottom lead attached; namely, bars $A$ and $D$. The top leads are next put down. The lead of coil No. 1 is put in bar No. 33. Bars $A$ and $B$, also $C$ and $D$, are considered as one bar. $A$ and $B$ is No. 1 and $C$ and $D$ is No. 32. Top leads are put down in regular order until bar $F$ is reached. The next top lead will go in bar $A$, then skip bar $B$ and put the lead in No. 1. Proceed until bar No. 31 is reached then the next and last lead will go in bar $D$.

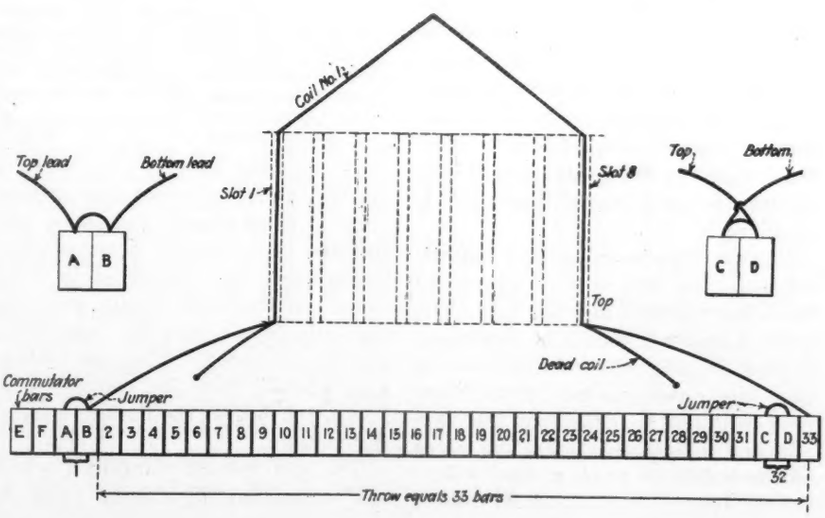
The leads must be put down carefully so that the proper ones will be put in bars $A$ and $B$ and $C$ and $D$, which should be considered as two larger bars, making a winding with sixty-three bars.

Adrian, Mich. C. A. JOHNSON.

* * * *

In rewinding the wave-wound armature which has 32 slots and 65 bars, please advise R. A. C. of Detroit, Mich., that he must use a "jumper" to connect bars 1 and 33 the same as if there were another

**How 65 commutator bars are connected to 63 coils.**



coil. He must use 64 coils and not cut out any. The 64 coils and one "jumper" make 65 coils. By connecting bars 1 and 33 the winding will come out all right.

Darby, Pa. G. W. HANLON.

* * * *

**Charges for Maintenance Service.**—I have a number of motors which I am taking care of on a monthly basis. Please offer suggestions for a basis of rates for this service which has been found satisfactory in other locations.

Denver, Colo. W. C. M.

I have noticed the inquiry in the May issue, page 238, on maintaining motors. This has been tried a number of times in this section without success mainly because the service firms were without capital to insure their success. What we do is rent motors and similar machinery and this is handled at a stipulated rental condition that the renter shall keep the machine in a condition equal to that as delivered barring natural wear and tear incident to full normal or overload use, thereby standing the repair charges if the trouble is due to negligence.

We have several hundred motors ranging from ¼-hp. to 50-hp. in operation on this basis.

Seattle, Wash. W. M. PRICE.

* * *

**Plugging Holes in Slate.**—What is a good substance to use to fill holes and cracks in slate switchboard panels? I have tried plaster of paris and shellac but when this compound dries it shrinks and leaves a space between the filling and the slate.

Boston, Mass. H. S. K.

To fill holes not required in a switchboard panel, secure some of the material of which the panel is constructed, powder this and mix with plaster of paris or even cement. If the panel is of slate or asbestos, mix the powder with a very small amount of water, the smallest amount required to properly make the mixture workable. Sometimes a very small quantity of lampblack will help secure the gray slate color that is required.

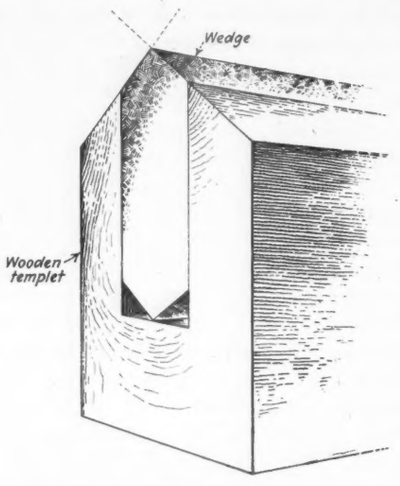
Place a thin board with a smooth surface upon one side of panel and force the mixture into the hole. The bore of the hole should be dampened before forcing the mixture in, so that the outer surface of mixture plug will not be dried out too rapidly and shrink away from the edges of the hole.

Gary, Ind. A. L. GEAR.

**Making Fiber Wedges.**—If some repair man will tell me a good way to cut good slot wedges from fiber and how they can be beveled, I will be most grateful.

Memphis, Tenn. C. L. M.

Fiber wedges up to and including 1/16 in. thick can be cut by hand- or foot-power shears. For ⅛ in. and thicker than could be cut on band or circular saws, the bevel can be put on with a Wallace bench saw, or any saw that can be tilted. A special shaper tool can be made and the bevel cut on the shaper. It may also be cut with a hand plane. A wooden template is made in the form of a trough into which the wedge will fit tightly and project the height of the bevel above the template surface, as the accompanying drawing shows.




**Fiber wedge is put in this template to cut bevel edges with a plane.**

Detroit, Mich. A. C. ROE.

* * * *

**Transformer Connections.**—In the case of a three-phase, four-wire, 4400-volt distribution circuit with grounded neutral, please show the proper transformer connections and how the transformer coils are connected. Are the three phases 120 electrical degrees apart and should the secondary be grounded?

Ontario, Canada. P. R.

In the May issue P. R. asked a question on transformer connections:

In a three-phase, four-wire circuit the three legs of a three-phase transformer are connected in Y or "star" on the high voltage side and the middle or neutral connection can be grounded. The low voltage side should then be connected in "delta" to deliver the motor or lighting voltage.

The low voltage windings, which are connected in "delta" can be grounded at any point, preferably at the middle of one of the legs. This would minimize the danger in the case of a breakdown between the high and low voltage coils.

The three phases are 120 electrical degrees apart.

Westinghouse Electric & Mfg. Co.,
East Pittsburgh, Pa. L. G. MASON.

* * * *

In publishing my answer to transformer connections in the June issue two mistakes were made. In the drawing the draftsman made the mistake of bringing in the neutral and connecting it to the transformers. This is contrary to my drawing as I do not use the neutral but only the three phase wires. This is very important in case of power banks where a motor load only is used and the load is balanced. It is considered standard practice not to use the neutral for power banks for the reason that with the neutral connected to the transformers, should one of the phase fuses blow, the motor would get its total load from two transformers and perhaps burn out the two transformers, whereas if only the phase wires are connected, should one of the phase fuses blow, the motor would then operate single phase until the other fuses would blow.

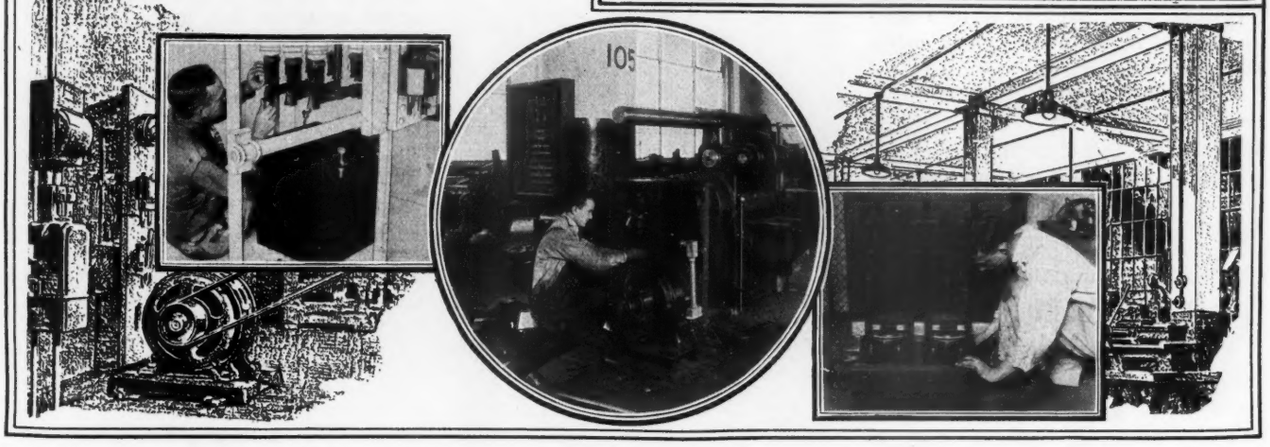
In the case of lighting loads where it is impossible to maintain a balanced load or for step-down substations where mixed loads exist, it is necessary to bring in the neutral and connect it to the transformers because a return current would then flow in the neutral. The drawing as shown in the June issue is for mixed loads and used on step-down substations, but not on power banks for motor service. I am very anxious this should be understood for the reason that the neutral connection for motor service might cause serious trouble.

In the second paragraph regarding grounding of secondaries it should be pointed out that the Illinois Public Utilities Commission requires this and operating companies in the state of Illinois are very anxious to comply with the rulings of the Utilities Commission for the reason that they are rated according to the manner they follow out the commission's rulings. The commission has engineers who travel all over the state and make it their business to see that the commission's rulings are respected.

Galva, Ill. C. W. ROSELLE.

# SERVICE
## *around the works*

*For this section ideas and practical methods devised to meet particular operating conditions are invited from readers. The items may refer to inspection, overhauling, testing or special installations.*

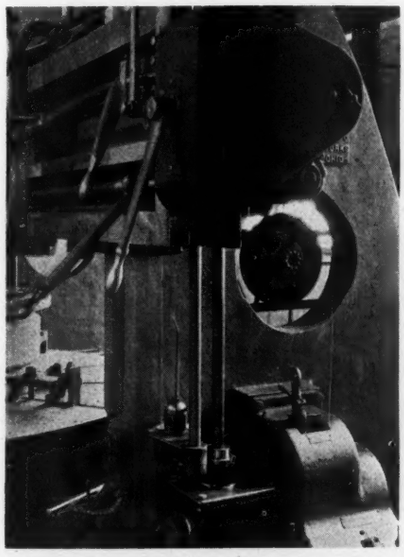


### Adjustable Speed Control Rheostat Mounted on Frame of Boring Mill

AN INGENIOUS method of mounting a field rheostat controlling the speed of a motor driving a large boring mill in a New England factory is shown in the illustration. The mill is equipped with push-button control for starting and stopping the motor and some of the speed changes are obtained by adjusting a rheostat which is installed in a circular opening in the frame within easy reach of the operator's hand and mounted on horizontal iron straps screwed into the frame.

This location of the rheostat not only makes it easily accessible but keeps it out of the way when material is being handled. H. K.

Boston, Mass.



**This is a convenient and accessible location for a control rheostat.**

### Crane Feeder in Conduit Has Eliminated Trouble With Flexible Cable

A THIRTY-FOOT jib crane over a malleable-iron furnace in the foundry of a Connecticut plant formerly caused so much trouble that it was used only when absolutely necessary. The crane beam swings through a ninety-degree arc, being pivoted at one end, and carries an electric hoist which travels its whole length and is used to open and assemble the furnace bungs. A three-wire flexible cable extending from the switchbox on the wall to the three horsepower induction motor on the crane carriage was the cause of the trouble. This cable was supported on a sheave but often ran out of the groove just when the hoist was about to be used. An idler sheave provided with a counterweight helped to keep the cable taut but delays were frequently caused by the cable becoming kinked. It was finally decided to do away with the cable and feed the motor by a conduit line from the pivoted end of the I-beam.

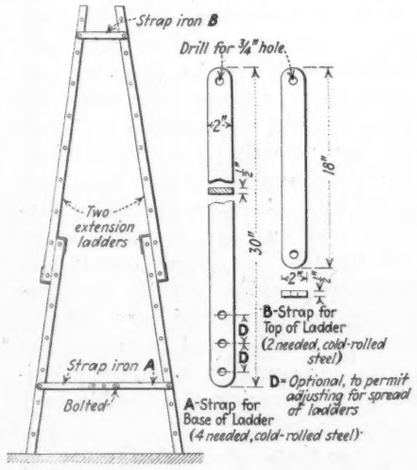
Accordingly a few lengths of ¾-in. conduit were strapped along the beam above the cross-bars holding the live rail insulators and fitted with a condulet and porcelain cover at each end. Three No. 10 solid wires were used, which terminated in stranded flexible wire at the pivoted end of the beam. The line from here to the switchbox was also carried in conduit, the flexible wire being coiled and looped at the point where the swinging motion was least.

Since the cable was eliminated no trouble has been experienced in operating the crane.

East Berlin, Conn. H. S. RICH.

### An Easy Way of Making a Strong and Portable Scaffold From Two Ladders

IN ELECTRICAL construction and maintenance work, especially in industrial plants, many occasions arise where scaffolds are necessary due to the impossibility of using lad-




**Here is a way of using two extension ladders as a quickly set-up scaffold.**

ders in the ordinary way. Often, however, the expense and trouble of erecting a scaffold does not seem to be justified by the amount of work to be done. By using steel straps as suggested in the accompanying sketch, two ordinary extension ladders may be utilized to form a self-supporting structure which is easily assembled and set up.

Cold-rolled steel ½ in. by 2 in. is employed. One end of each strap is permanently bolted to the ladder leg and when not in use is simply swung up parallel to the ladder and hooked in this position. J. B. RAKOSKE.

Schenectady, N. Y.

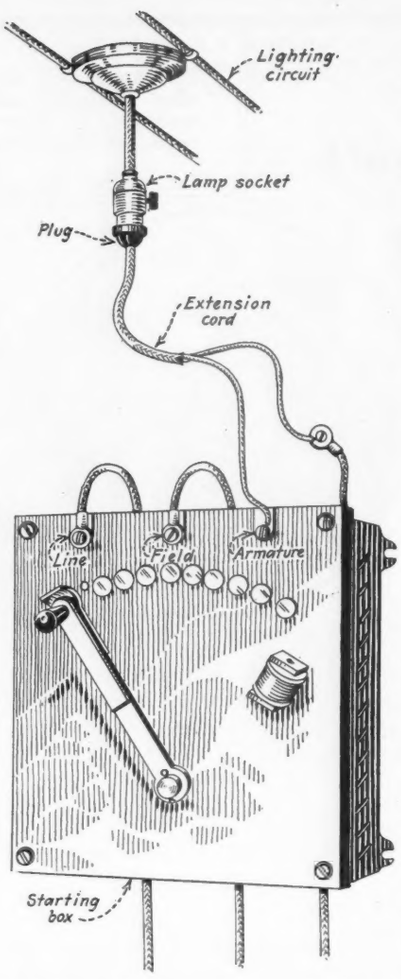
## How Chain Eliminated Trouble of Belt Drive on Short Centers

A SHORT belt drive on a refrigerator plant installed in Chicago a few months ago, kept giving trouble. After changing the belt several times without success, a careful study of the conditions led to the use of a chain drive which did away with all the difficulty.

This installation was a small automatic refrigerating plant which should require only occasional attendance. All of the machinery was mounted upon a unit base, the compressor being belt driven by a 2-hp. squirrel-cage motor using standard pulleys at 4-ft. centers. The motor was rated 1,200 r.p.m., 220-volts, three-phase, 60 cycles. It was started by an automatic switch controlled from a thermostat.

When first allowed to operate without attendance the motor had started but the belt slipped and the compressor would not start, thus allowing the motor to spin and its pulley to burn the belt. A new leather belt was installed under still greater tension which operated satisfactorily for a few days when the motor burned out, presumably from the heavy starting current required. The refrigerating plant had been meanwhile otherwise operating perfectly and was not responsible for the trouble. A larger motor was suggested having greater starting torque, but this would have reduced the power-factor and increased the power consumption with the possibility of throwing the trouble back on to the belt.

It was therefore decided to use the same motor and install the silent-chain drive. This necessitated replacing the compressor flywheel pulley with a new flywheel gear, and the motor pulley with a pinion. The chain was then installed and encased in an oil-tight housing. The total cost of the change was $90 allowing nothing for salvage on the replaced flywheel, pulley and belt.




**How the rheostat was plugged into the lighting circuit to give variable armature resistance.**

As the chain was allowed to run very slack the strain on the bearings was greatly reduced. The machine then operated perfectly. A recording wattmeter put on the motor circuit for two weeks showed that the input to the motor at starting now never exceeded 1.8 hp. The input remained at this value for about 2 minutes then reduced to ¾ hp.

This power curve would indicate that whereas with a belt drive on such short centers a 2-hp. motor was found inadequate to drive the machine, 1¼ hp. would be sufficient with a silent chain drive.

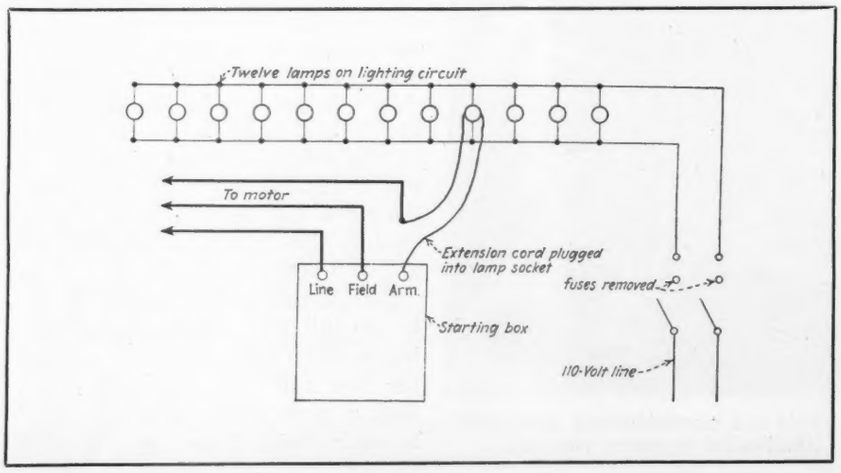
Chicago, Ill. THOMAS NAFZIGER.

## Lighting Circuit Used as Rheostat for Speed Control on Special Work

HAVING a lathe job recently that required a lower speed than was obtainable under existing conditions a lighting circuit was used temporarily as a variable rheostat placed in series with the motor. The fuses were removed from the circuit, which was one supplying about 12 lamps. At the starting-box of the 110-volt direct-current ½-hp. motor running the lathe, the wire from the binding post marked "Arm" was removed and one wire of an extension cord was connected to it. To the binding post was connected the other wire of the cord, which was screwed into a lamp socket on the circuit.

The lighting circuit now formed an adjustable lamp-bank in series with the motor armature. When starting the motor some of the lamps must be turned on. After starting the motor in the usual way, different speeds of the motor could be obtained by cutting in or out lamps as required. DEXTER W. ALLIS.

Whitman, Mass.

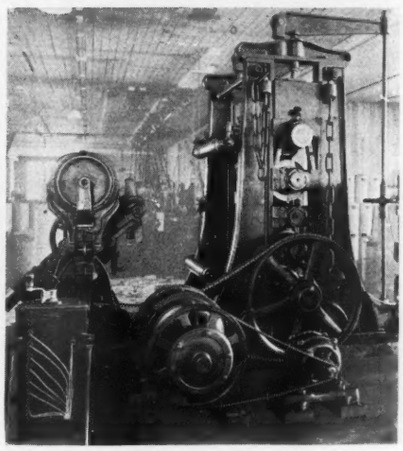



**How lamp circuit was connected to give speed control on motor.**

## How a Simple Chain Drive on a Stack Calender Saves Floor Space

AT THE factory of the Springfield (Mass.) Glazed Paper Co., a greatly improved drive for a stack calendar has recently been installed by J. H. Whitehouse, superintendent of the company. The equipment illustrated in the accompanying photograph, consists of a 6-roll, 34-in.-face calender, with a double motor drive.

The machine is started by a 5-hp., 440-volt, two-phase General Electric induction motor which drives the unit for a paper feeding speed of 40 ft. per minute. This drive includes the rotation of the main driving motor. When the latter, a 25-hp. unit, is brought into service the smaller motor is automatically cut out and the main motor gives a paper feeding speed of about 400 ft. per minute. An electric brake is provided in the larger motor circuit to insure quick stopping, and this motor is controlled by a drum-type controller giving a speed range of about 50 per cent. The larger motor operates at 720 r. p. m. synchronous speed and at about 680 r. p. m. under full load. The drives from the small motor to the main shaft and from the larger motor to the calender shaft are by Link-Belt chains. The absence of gearing and leather belting in this drive has resulted in a marked saving in floor space over the previous arrangement.

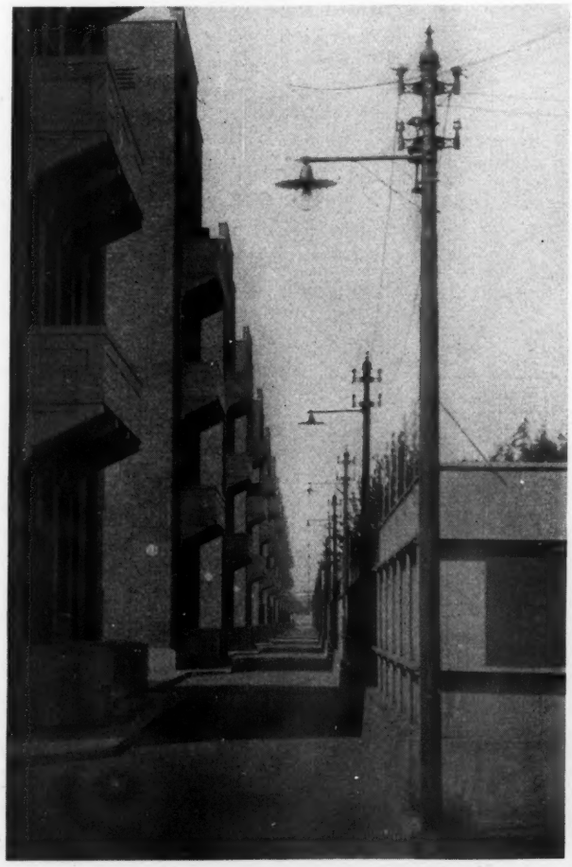


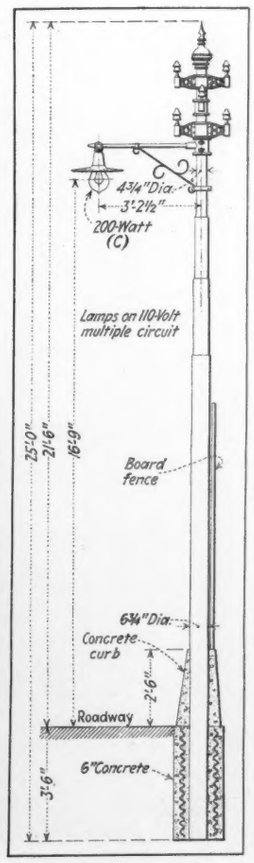
**Here is a unique chain drive for a calender.**
The small motor at the right is used for starting. When the large motor is thrown into service the small motor is automatically cut out.

## Standardized Brackets Provide Attractive Factory Roadway Lighting Installation

THE Bridgeport (Conn.) factory of the General Electric Company is bordered on the east by a driveway 2,084 ft. long, which is effectively illuminated by twenty-nine 200-watt gas-filled lamps carried with reflectors 16 ft. 9 in. above the ground and at the ends of bracket arms 3 ft. 2½ in. long. The brackets are fastened to 25-ft. posts 4¾ in. in diameter at the collar and 6¾ in. in diameter at the base. The posts are set into the earth for a depth of 3 ft. 6 in. and are surrounded below the surface by 6 in. of concrete reinforced with wire mesh. In most cases the poles are protected for a distance of 2 ft. 6 in. above the ground by a concrete curb surmounted by a board fence, as shown in the accompanying illustrations. The standard spacing of the poles is 70 ft., and the lamps are operated on a 110-volt multiple circuit fed from overhead. H. K.

Boston, Mass.






**These lighting brackets do not take up space in either the yard or the roadway.**

## Method of Supporting Varnished-Cambric-Insulated Risers in Buildings

VARNISHED - cambric - insulated cables may be used to good advantage as vertical risers for elevator feeders in buildings. This is because varnished cambric stands a greater heat than rubber insulation and the National Electrical Code therefore permits a higher current-carrying capacity for cables insulated with varnished cambric. This saves copper. Also a small IR drop is not as important with machinery as with lighting.

The problem of supporting such cables, however, presents features which do not exist with rubber-insulated cables, for the reason that the weight of the copper conductor is liable to cause it to slip through the varnished cambric if supported by blocks in the conduit.

An excellent method is shown on the next page as used at the Fifth Avenue branch of the Guarantee Trust Company, New York City. The insulation is stripped off the copper wire and the latter terminated on strain insulators attached to the steel work of the building to carry the weight of the copper. Blocks in the conduit keep the varnished cloth from slipping.

The cables are then covered with a winding of cloth somewhat similar to lamp wick and saturated with a flame-proofing compound.

F. A. WESTBROOK.
Field Engineer,
Habirshaw Electric Cable Company,
Yonkers, N. Y.

## Safety and Economy Are Important Considerations When Wiring the Industrial Plant

SAFETY and economy should be kept constantly in mind when wiring the industrial plant for power and lights. All wiring behind the engine room switchboard and up into the wire tower, if one is used, should be slow-burning, if it is not in conduit. In case of a short circuit or a fire, slow-burning wire will not carry fire readily, nor will the insulation all burn off.

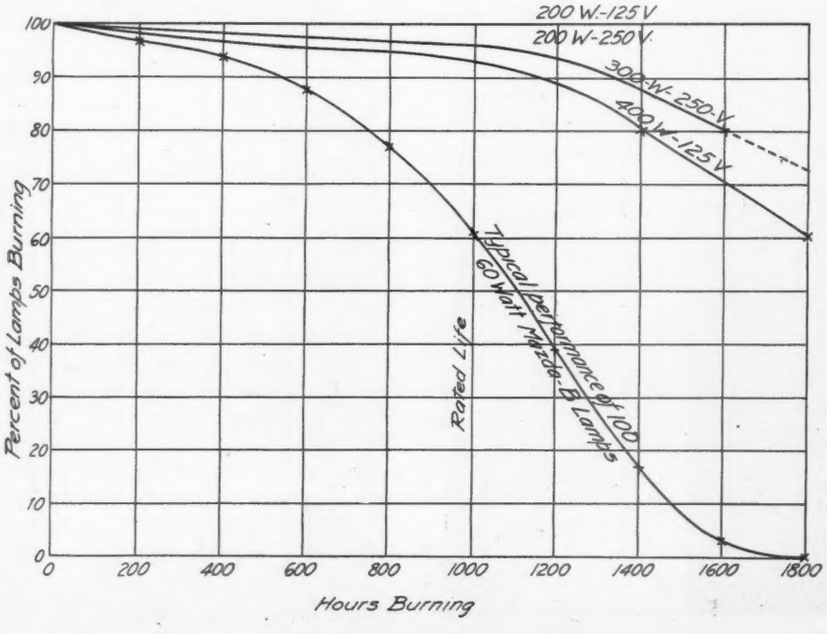
Throughout the various departments all wiring on the side walls should be in conduit, whether they are lighting lines to switches or power lines down to a starter or up to a motor; also all lines through the floors should be in conduit in preference to porcelain tubes or loom.

All lines on the ceiling or beams may be rubber covered, supported on split knobs one inch high, well spaced, straightly run and turned squarely at corners for neat appearance. In dry, inside locations, slow-burning wire is good enough and absolutely safe, but in all damp places and out-of-doors rubber-covered wire should be used. Always keep power, light, bell, telephone and clock lines well separated; if too close, a ladder may force them together and cause trouble.

**Cable insulated with varnished cambric is supported by strain insulators.**

The cable is held in the ordinary manner by blocks in the conduit, but the additional support is required to prevent the conductor from slipping inside the insulation.

**Performance of Mazda C lamps on life test compared with Mazda B lamps as standard. These tests were made on lamps in actual service.**




If all power lines on 440 volts are knobbed five or six inches apart they can be readily distinguished from the 110-volt lighting lines run 2½ inches apart.

When running feeders or mains to any department, keep them high up or otherwise well out of the way so that they will not be tapped into for any other use. When computing circular mil sizes for mains, allow not over 2½ or 3 per cent drop in voltage at the lamps, and about the same at the motors at full load.

Do not allow wiring to come in contact with dripping liquids, live steam or hot pipes. In running wires through partition walls, it is safer to keep them in channels or openings by themselves rather than to crowd them through alongside of pipes. For wiring around large furnaces, as in foundries, and so on, use slow-burning wire instead of rubber-covered, to withstand the heat.

Green, cotton-covered lamp cord may be used for small lamps, but for large lamps with heavy reflectors use reinforced cord or conduit stems. For portable machines or extension lamps, use heavy reinforced cord. Solid wire may be used up to and including No. 6, but all over that size should be stranded for easy handling around bends; besides, large sizes of solid wire are liable to break in handling.

H. S. RICH.
Little River, Conn.

## Direct Tests Show That Type C Mazda Lamps Have Long Life

IN ORDER to prove that certain sizes of Mazda C lamps were not of abnormally short life, as the men responsible for the purchase of lamps for an industrial plant had supposed, the writer ran a simple test for the length of life of the lamps in question.

Five lamps of each of the sizes indicated on the curves were chosen at random from the stocks. These lamps were connected in circuits where they would burn continuously and were inspected every night and morning, so that the time when they gave out could be determined within a few hours.

After the lamps had burned fifty per cent more than their rated life, the results were plotted for comparison with a curve which was accepted as typical and plainly showed that the length of life of the lamps was satisfactory.

D. W. BLAKESLEE.
Pittsburgh, Pa.

## Switchboard Construction That Combines Safety and Flexibility for Extensions

REGULATIONS which are becoming effective in different states and municipalities that specify "dead front" switchboards have called for a new type of switching equipment for voltages up to 600 direct and alternating current. The first condition to be met is that such equipment has to be sold for the same if not a lower price than slate boards. Second, they must be suitable for the same class of mounting, such as angle-iron or wrought iron pipe frames.

The panels must be of such a size that they will make up the same as the standard widths and heights universally adopted and at present in use. Manufacturers of safety switchboxes have recently placed on the market steel panels punched, formed and enameled which meet all the requirements of this new type of switchboard. They have been tried out in several of the large industrial plants and have proven satisfactory.

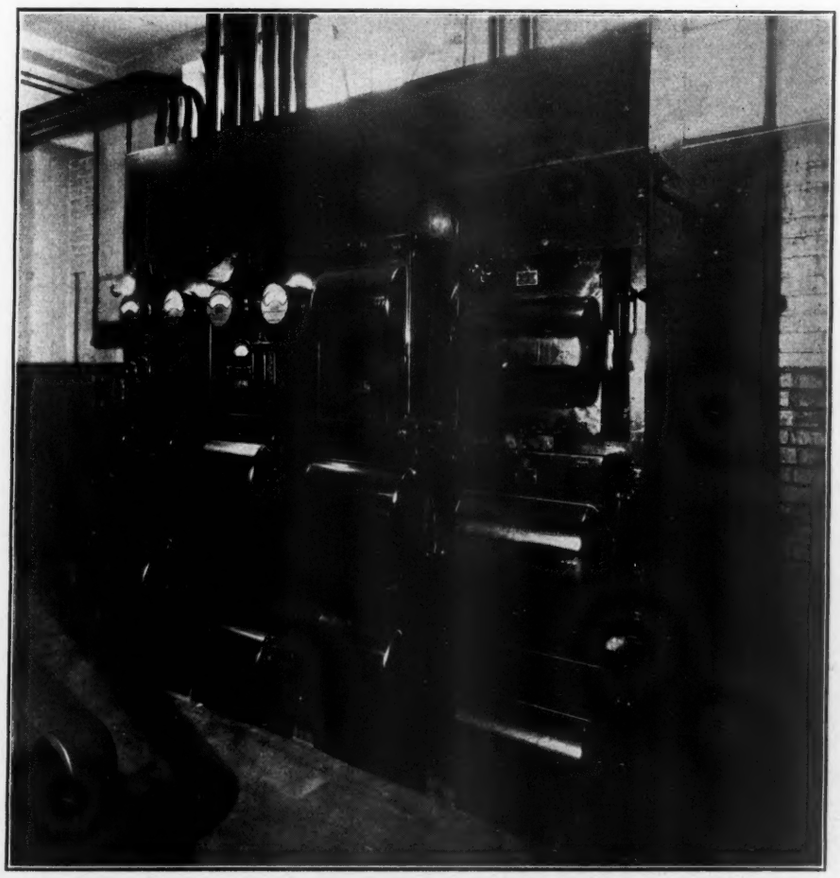
The flexibility of the steel panels is an important point in favor of this new type of switchboard. The panels with the switchboxes may be carried in stock and a board can be made up on very short notice to meet the demands in industrial plants where alterations and extensions are made on short notice. This condition is a very important one from the contractor-dealer's point of view also, since he is able to take the required parts from his stock or obtain them on short notice from a jobber's stock. They can be shipped to the job and made up to suit any requirement which may arise from changes when the job is nearly completed, due to some new condition which had been overlooked previously. Moreover, the control for groups of small motors up to 5 hp. may be grouped on such boards, making a very efficient and mechanical arrangement.

The accompanying illustration shows an installation in an industrial plant in Detroit, Mich., where electrical energy is generated by a steam engine direct connected to a 220-volt, 60-cycle alternator. The control for the generator with meters and rheostats is mounted on panel 1. The control with the meters for the exciter is mounted on panel 2. The remaining switches are for feeder control. The type of switch used is very desirable for feeder control, as it is possible to lock the switches in the off position when it is desired to prevent any circuit from being made alive when work is being done on this particular circuit, thus preventing the accidental closing of switches which so often occurs with other types of switchboard. The question of grounding can be very easily taken care of, as the several equipments are all mechanically connected. This makes conditions ideal for good grounding and by grounding at one point all equipment is protected.

The panels are mounted on an angle-iron frame similar to the types used for standard switchboard construction, with a channel-iron base and channel-iron wall supports. These panels are provided with flanges for bolting them together and these flanges can be used for bolting the panel to the vertical members of the frame. In the wrought-iron pipe frame suitable cross angles can be used if the panels are to be used with this type of frame. The mains are entirely enclosed in a gutter box. All conduits are connected to this box, which provides a very good bond for the grounding of conduits. It is very convenient to interchange the circuits to the extreme sections of the board through the gutter box. The cases of meters are all well grounded as they are bolted to the steel panels. The entire switchboard both front and rear is dead so that it is unnecessary to provide guard rails or enclosures. Any arcing or heating is retained in the boxes and gutters, which prevents fires being started from the switchboard equipment.

Hamilton, Canada. V. K. STALFORD.

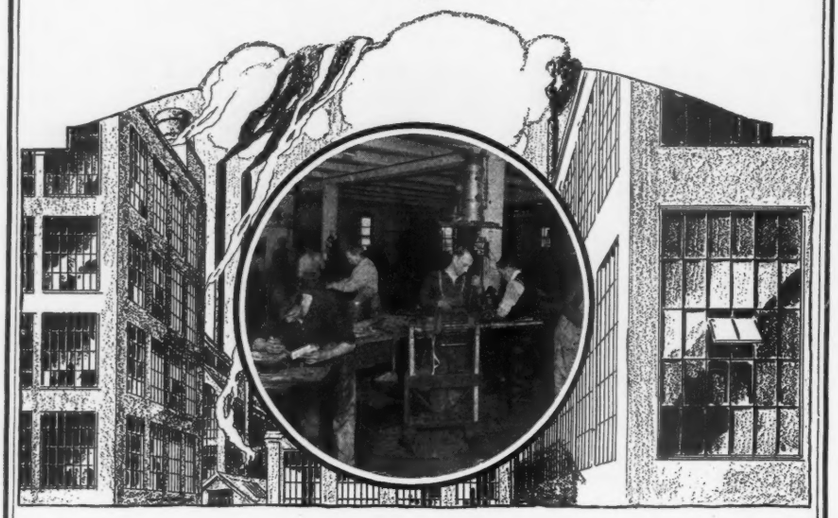
**Equipment and parts for this board can be carried in stock and changes made as needed.**



## Economical and Safe Dead-Ending for Heavy Cables Inside of Factory

A METHOD of supporting cables inside a building which makes a neat and strong job is to have each cable spliced to a turnbuckle to the other end of which is attached a strain insulator and a ring bolt. The bolt is fastened through an overhead beam and the turnbuckle is used to draw the cable tight. Instead of taping the exposed part, a fiber tube is slipped over the turnbuckle and exposed wire, and porcelain cleats are clamped on the wire to prevent the tube from slipping off. E. H. H.

# In the Repair Shop



*This section is devoted to all sorts of electrical repair work, large and small. Special attention is given to tools found convenient at the shop bench and short cuts or improved methods. Articles on these subjects are always welcome.*

## Welding Current Should Be Proportional to Thickness of Metal Welded

ELECTRIC arc welding is frequently done with too low current values, resulting in poor welds. With a given arc length the quality of fusion is improved by increasing the arc current up to a certain maximum. If the current used is lower than this maximum value, then the heat liberated at the crater is not great enough to properly fuse the parent metal, with the result that the bead will show excessive overlap and poor penetration. If the arc current exceeds the maximum value the heat at the crater is too great, and the penetration is very deep. Owing to the difference in the amount of metal necessarily heated in making various types of welds, this factor must be considered in determining the current. The attached table gives the approximate current values for horizontal butt welds on steel plates made with bare electrodes using direct current. For lap welds multiply the current values by 1½, and for strap welds, by 1¼.

San Jose, Cal. D. N. LOUIS.

RELATION BETWEEN PLATE THICKNESS AND ARC CURRENT

| Plate Thickness Inches | Arc Current Amperes | Electrode Dia. In. |
|---|---|---|
| 1/16 | 20- 50 | 1/16 |
| 1/8 | 50- 85 | 3/32 |
| 3/16 | 75-110 | 1/8 |
| 1/4 | 90-125 | 1/8 |
| 3/8 | 110-150 | 5/32 |
| 1/2 | 125-170 | 5/32 |
| 5/8 | 140-185 | 5/32 |
| 3/4 | 150-200 | 3/16 |
| 7/8 | 165-215 | 3/16 |
| 1 | 175-225 | 3/16 |

## Nineteen Items of Data Which Should Be Kept When Motors Are Rewound

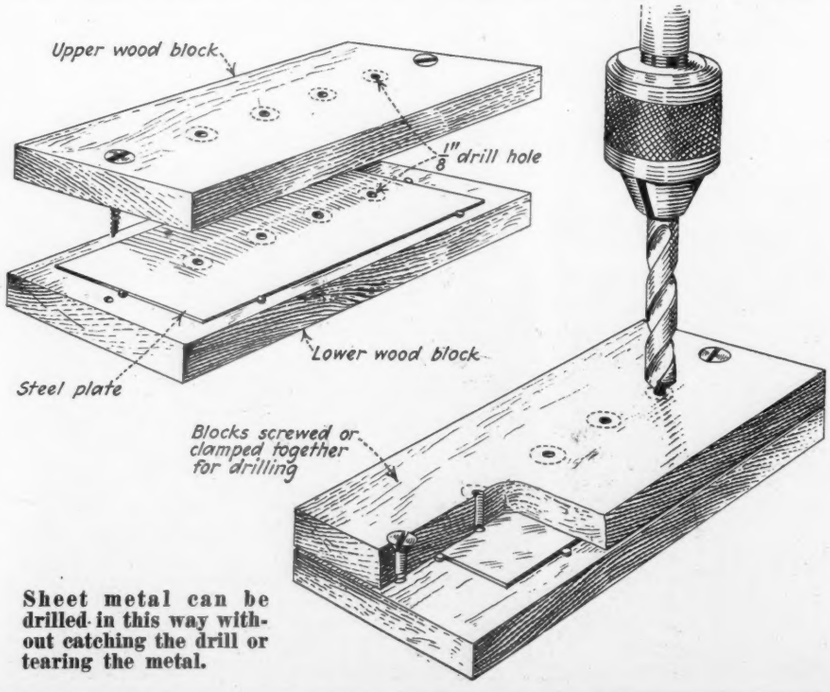
WHEN a motor is being rewound the following data should be taken and filed for reference: The make, serial number, horsepower, type, voltage, number of phases, frequency, speed, number of poles, number of slots, number of coils, throw of coils, number of turns per coil, size of wire, kind of insulation, number of wires in parallel per coil (if more than one), number of coils per group, whether star or delta, and total weight of wire necessary to rewind. This makes a rather complete record, but each item will be found of value. W. R. GIBSON.

Chief Electrician,
Calumet & Arizona Mining Co.,
Warren, Ariz.

## A Simple Template to Use in Drilling Large Holes in Thin Sheet Steel

SOMETIMES it is necessary to drill large holes in a steel plate which is part of a panel box or switch box and difficulty may be experienced in holding it so that it may be safely and neatly drilled.

When doing such work, first mark out the exact location of each hole on the surface of the steel plate. Lay the plate on a 1-in. board somewhat larger and secure it with a few short nails to keep it from shifting while being drilled. Then run a ⅛-in. drill through the steel plate and the board at the center of each hole marked out to be drilled. Now turn over the plate and board together and place them on another 1-in. board. The center holes made by the ⅛-in. drill will now be on top in full view. Fasten both boards together with a few strong wood screws, the steel plate being between.




**Sheet metal can be drilled in this way without catching the drill or tearing the metal.**

Using the size of drill desired, center it over each ⅛-in. hole in succession and drill through into the lower board. The steel plate will be drilled neatly and without buckling up when the hard cut comes.

A steel box that can be carried to a drill press may be drilled in about the same way; that is, by clamping one board above and another below, having the center of each hole marked on the upper board to guide the large drill through the plate.

New Britain, Conn. H. S. RICH.

## Rack for Small Reels Maintains Proper Tension on Wire

AS THE tension under which wire is drawn from the reels in winding operations affects the ease and speed of working, the rack shown in the illustration was built for holding and controlling reels of wire ranging in size from No. 20 to No. 40. The tension is adjusted by springs which control the pressure of blocks against the ends of the reels.

The blocks are attached to a cross arm with machine screws, the ends of the screws being filed flush with the concave surface of the blocks. The tension bolts are threaded and firmly screwed into the two outside holes tapped in the arm, so the bolts will not turn when adjusting the wing nuts. To load the rack the reel is held so that the ends fit into the grooves of both tension blocks. The shaft is slipped through the reel and the cotter pins replaced so the shaft will be held in place. The reel may be rotated in either direction.

Detroit, Mich. A. C. ROE.

## Diagrams for the Repair Man to Record Coil and Commutator Throws

WHEN a burned-out armature is to be rewound in a repair shop with the same winding as originally used, some record should be made of the coil and commutator throws before the commutator is stripped. The diagrams that are used for this purpose in one large repair shop are shown in the accompanying illustrations. They are used as follows:

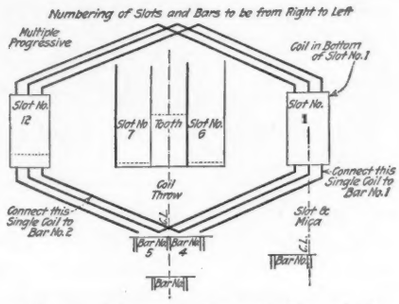

Numbering of Slots and Bars to be from Right to Left
Multiple Progressive
Coil in Bottom of Slot No. 1
Slot No. 12
Slot No. 7
Tooth
Slot No. 6
Slot No. 1
Connect this Single Coil to Bar No. 1
Coil Throw
Connect this Single Coil to Bar No. 2
Slot & Mica
Bar No. 5
Bar No. 4
Bar No. 1

**Fig. 1—Diagram for entering winding specifications for a lap winding.**

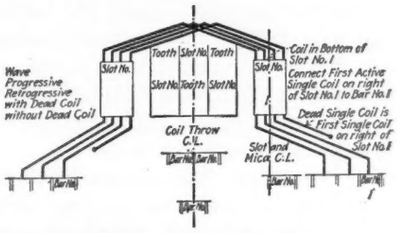
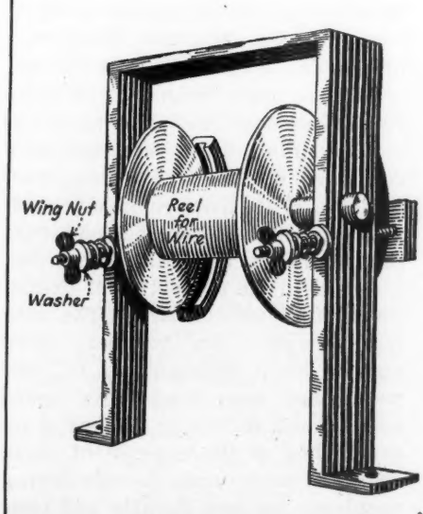

Wave Progressive Retrogressive with Dead Coil without Dead Coil
Slot No.
Tooth
Slot No.
Tooth
Slot No.
Slot No.
Tooth
Slot No.
Coil in Bottom of Slot No. 1
Connect First Active Single Coil on right of Slot No. 1 to Bar No. 1
Dead Single Coil is 1st First Single Coil on right of Slot No. 1
Coil Throw C.L.
Slot and Mica C.L.
Bar No. 1

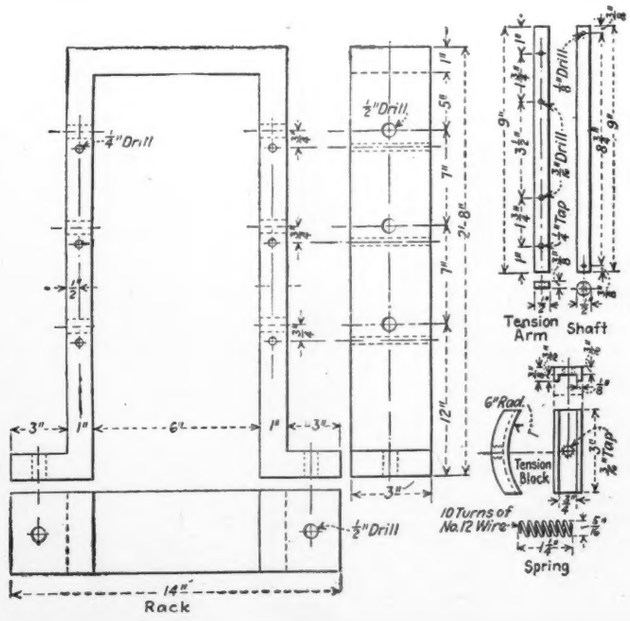
**Fig. 2—Diagram for entering specifications for a wave winding.**

Before removing all of the coil terminals from the commutator neck, one coil is tested out to locate the slots in which the sides lie. The coil side in the bottom coil (in a double-layer winding) will be in the top of a slot, a distance which is called the coil throw. In Fig. 1 the bottom-coil side is in slot No. 1, and the top-coil side in slot No. 12, so that the coil throw is 1 and 12. Next the center line of the coil is determined and marked on the diagram so as to show whether it falls in a slot or on a tooth, and also at the commuator on a bar or on a mica between bars. If the number of bars is an even number, the center line will fall on a bar, but if it is an uneven number, the center line will fall on a mica. In the case of a lap winding, commutator bar No. 1 is assumed to be directly under slot No. 1, as in Fig. 1. Then the number of bars is counted between bar No. 1 and the bar to which the terminal of the coil side in slot No. 1 is connected. This number is marked on the diagram. In Fig. 1 it is 4, as shown.

With the diagram marked in this manner, the remaining coils can be removed from the armature and the commutator removed if necessary. When repaired it can be replaced and lined up by means of the diagram.

**Tension on wire is varied by turning wing nuts. The details of the rack for wire reels are shown below.**



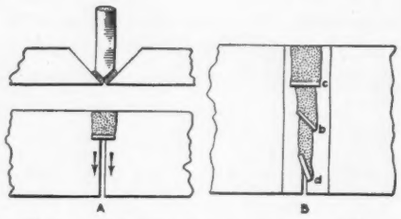



From the diagram the armature winder can also tell the type of coil needed and can easily locate the commutator bar to which the bottom lead of the first coil is connected.

In Fig. 2 the diagram used for a wave winding is shown and drawn in such a way that it can be used for a continuous-wave winding or one with a dead coil. The same procedure is followed as in the case of a lap winding except that bar No. 1 is taken as the one to which the bottom-coil side is connected and the count to the center line of the coil is made from bar No. 1 toward the left. Then the coil throw is marked in the slot spaces provided in the diagram, the center line of the coil being indicated as falling on a mica or on a commutator bar. In the former case the proper numbers are marked on the bars each side of that mica, and in the latter case the proper number is marked on the bar, always counting to the left from bar No. 1. It should also be noted whether the center line of the coil falls on a slot or a tooth, and the numbers entered.

## Flat Welding Electrode Requires Less Skill

LESS time and skill are required for welding seams with an electrode in the shape of flat wire than with the common round electrode. The flat electrode, *A*, assumes a "V" shape, corresponding to the V in which the weld is being made, owing to the fact that the arc centers at those points are closest to the metal and thus melts off the electrode to a uniform distance from the welded metal. This relieves the operator from the necessity of skillfully weaving the electrode from side to side and down into the bottom of the notch. He has only to move the electrode along the seam and feed it into the arc as it melts off. After the weld is completed in the bottom of the notch the electrode is used as shown in *B* to produce a broad, uniformly flat weld.




**Flat electrode does not require weaving.**

When using this electrode it is necessary for a welder to carry only one size and use it either flat or edgewise for wider or narrower seams. The wire is also fitted for use with automatic welding machines, since it will give broad runs without side motion.

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CORRECT VARNISH TO USE FOR INSULATING COILS

| Characteristics of Clear and Black Baking Insulating Varnishes and Uses for Which They Are Recommended* | —Clear Varnishes— | | | ———Black Varnishes——— | | | |
|---|---|---|---|---|---|---|---|
| | Clear Quick Baking | Clear Quick Elastic Baking | Clear Elastic Baking | Black Quick Baking | Black High-Heat-Resisting Baking | Black Plastic Baking | Black Elastic Baking |
| Dielectric strength | 3 | 1 | 1 | 3 | 2 | 2 | 1 |
| Mechanical strength | 3 | 1 | 2 | 3 | 4 | 5 | 2 |
| Flexibility | 3 | 2 | 1 | 3 | 3 | 2 | 1 |
| Plasticity | .... | .... | .... | .... | .... | 1 | .... |
| Oil resistance | 2 | 1 | 1 | 2 | 3 | 4 | 1 |
| Water resistance | 2 | 2 | 1 | 2 | 2 | 1 | 1 |
| Life under heat | 4 | 3 | 2 | 4 | 2 | 1 | 2 |
| Treating cloth, paper and thin fibrous materials | 3 | 2 | 1 | 3 | 3 | 2 | 1 |
| Treating fullerboard and heavy fibrous materials | 2 | 1 | 2 | 2 | 3 | 3 | 2 |
| Small high-speed armatures | 3 | 1 | 2 | 3 | .... | .... | 2 |
| Intermediate-speed armatures | 3 | 1 | 2 | 3 | 3 | 3 | 2 |
| Large low-speed armatures | 3 | 2 | 1 | 3 | 2 | 2 | 1 |
| Field and stator coils | 3 | 2 | 1 | 3 | 2 | 1 | 1 |
| Automobile-starting motors | .... | 1 | .... | .... | .... | .... | .... |
| Vacuum-cleaner motors | 1 | 1 | .... | 1 | .... | .... | .... |
| Washing-machine motors | .... | 1 | 1 | .... | 1 | 1 | 1 |
| Street railway and electric locomotive motors | .... | .... | 2 | .... | .... | 1 | 2 |
| Fan motors | 3 | 1 | 2 | 3 | 2 | .... | 2 |
| Magnetos and induction coils | .... | 1 | 2 | .... | .... | .... | 2 |
| High-potential apparatus | .... | 1 | 2 | .... | .... | .... | 2 |
| Transformers | .... | 1 | 2 | .... | .... | .... | 2 |
| Average repair shop conditions | .... | 2 | .... | .... | 2 | 1 | .... |

* Numbers indicate order of suitability.

## Selection of Varnishes for Coil Insulation

BECAUSE the desirable characteristics for a perfect varnish cannot be combined into one compound, a number of varnishes have been developed, each having its own characteristic. The purposes of some insulating varnishes of the Sherwin-Williams Company are indicated in the accompanying table. Where more than one varnish can be successfully used the different types are indicated as first, second and third choices.

All of the varnishes mentioned in the table are of the baking type. However, insulating varnishes in general may be divided into several general classes, such as clear varnishes, black varnishes, baking varnishes and air-drying varnishes. The most marked difference between the clear and the black varnishes of course is the color, but owing to fundamental differences in the characteristics of the ingredients entering into their composition, there are also some differences in the physical properties of the varnishes themselves. As a general rule clear varnishes possess greater mechanical strength and resist oil better than black varnishes. An exception to this is the black elastic baking varnish shown in the table. Where extreme mechanical strength is required, as on small high-speed armatures, clear varnishes are best.

Black varnishes are not quite so strong mechanically as clear varnishes but are sufficiently strong for most purposes. On stationary windings, as on alternating current stator windings, the varnish is not subjected to centrifugal stresses and there is no advantage in using a clear varnish. Certain black varnishes are made from plastic materials and have the ability to withstand long-continued heating without hardening. Black varnishes, as a rule, are cheaper than clear varnishes, and are more commonly used.

The chief difference between baking varnishes and air-drying varnishes is in the proportion of oxidizing ingredients contained. The baking varnishes are tougher, more elastic, more resistant to oil and water, and have longer life under heat. Speed in drying is always accomplished at the expense of these characteristics, and the air-drying varnishes are less durable and elastic than the baking varnishes.

*Better ways to transport and handle raw and finished parts in and around the works will be discussed in this section.*

## How An Automatic Door Sill Speeds Up Handling Trucks On and Off Elevators by Eliminating Bumps

TRUCKING on or off elevators causes considerable trouble in many plants due to the jolt the truck receives as it goes over the opening between the floor of the building and the elevator. With even the thinnest approved elevator door, this opening is approximately four inches wide. Although the door partially fills this up, it is not substantial enough to hold up under heavy trucking. The result is repairs to the doors and also trouble in going over the rough spot. Broken wheels are not uncommon and delays from stuck trucks are frequent. In addition, where a fragile product or small packages are handled, considerable damage results through frequent spills or jolts, or from packages falling off the truck when passing over the opening.

One common method of overcoming this difficulty is by providing a steel toe-board hinged to the floor of the elevator which the elevator man swings up to bridge over this space when the doors are open. Before starting the elevator the operator is supposed to swing the toe-board back out of the way but sometimes forgets and causes a smash-up when the toe-board hits the upper door. Also he may forget or the trucker may push a truck across before the operator has the toe-board moved. Although this method is fairly satisfactory when properly carried out, inasmuch as its use depends upon the operator, failures are common and often expensive. One works manager who had used this style of toe-board for a number of years said that accidents required frequent replacing of the elevator floor because it was torn out when the toe-board got caught.

This manager, who handles a large amount of heavy trucking between floors on the elevator, has overcome his door problem by installing an automatic toe-board or door sill on his elevators. This automatic sill, instead of being mounted on the elevator, is hinged to the lower half of the steel elevator door, as shown at the left in the two accompanying illustrations. A guide wheel at each end, as pointed out by *A*, fits behind an angle-iron guide which holds this sill-plate vertical until it reaches the channel-guide near the floor as shown at *B*. The sill then automatically flattens out over the opening and is easily trucked over as shown in the illustration at the right. When the doors are closed the sill automatically is guided out of the way by the pressure of the roller against the angle-iron guide.

In three years of hard use the installation pictured here has not had any repairs or maintenance, is easier on the trucks and also has eliminated all loss from packages falling off the truck. It has speeded up the trucking on and off the elevator so that the one elevator has been able to take care of increased production. The Arnold Automatic Elevator Door Sill Company, Chicago, Ill., has installed a number of these door sills in plants in the Central Manufacturing District. The sill is made of ⅜-in. steel and will handle truck loads up to about 4,000 lbs. without sagging. The plate is wide enough

**He could truck eggs or glass in or out without a bump or a break.** The steel plate automatically fits down over the space between the floor and elevator, eliminating spills or breakage of truck wheels and other hold-ups which commonly result from trying to truck over the opening. Also the operator cannot forget because opening the door automatically puts the sill in place.

to permit about 2 in. of steel to rest on the floor on each side of the gap and support the load. Adjusting the counterweights takes care of the additional weight on the doors.

## How One Plant Employs Steel Dump-Body Skids to Handle Loose Material

ONE important point to consider in all installations of either hand or power lift trucks is the type of skid or platform to use. The advantage of the truck lies in reducing the time required for picking up, carrying and depositing the load. In addition, the design of the skid has a pronounced effect upon the ease of each of these three parts of the material handling operation. For example, the dump-body skid shown in the accompanying illustration which is used at the plant of the Great Western Smelting and Refining Company, Chicago, Ill., is designed primarily to facilitate loading and unloading. The skid is on wheels so that it can be moved about for short distances, when necessary to make loading easier, even though the storage-battery truck is not around. When loading in narrow quarters where it is impossible to place more than one truck at a time, the industrial truck deposits its empty skid to one side, picks up the loaded skid or buggy and goes directly to its destination. Because the skid has wheels, the loading gang can push it into position as quickly as the truck could stop and place the empty buggy. When there is more space the truck deposits the buggy in the proper position for reloading.

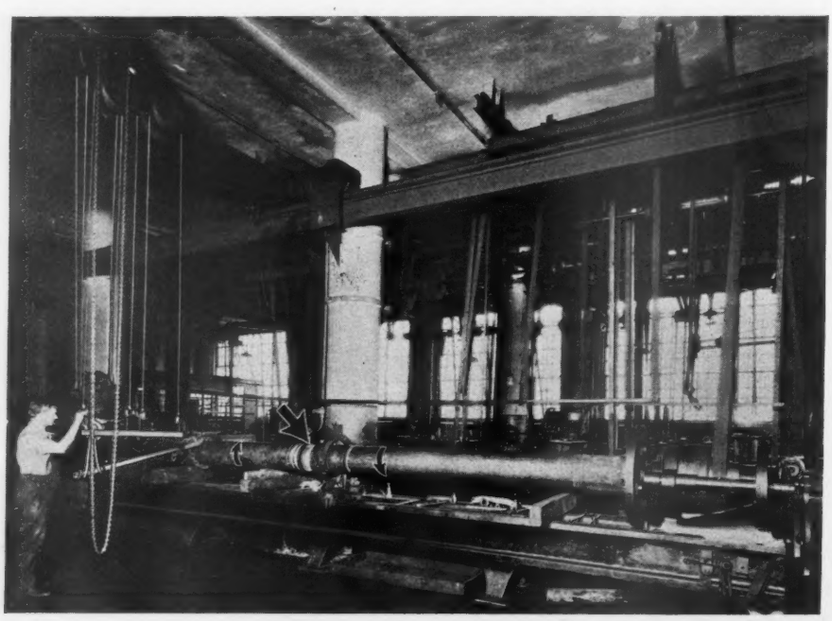
**These special dump-body skids for elevating-platform trucks simplify the handling of scrap and refuse.** The skid is provided with wheels so that it can be moved about even if the truck is not available. Also, it can be dumped at its destination and taken away again or deposited and dumped when desired even though the truck has moved away. Notice particularly the wheel upon which the dumped truck rests instead of dragging when the truck backs away from the pile.

When the elevating-platform truck and its load arrives at its destination the dump-body skid may be emptied at once or set down and dumped later. In the case shown the dump-body was loaded with old storage battery plates to be melted up for the lead. As the body is dumped, the front rests upon two wheels which project forward, as shown, and supports the skid as the truck backs off. The dump-body is almost balanced so that it is easy to straighten up when empty. Ordinary platform skids are used to handle pig metal or other material which may be easily piled. Much time and labor is saved by using the proper type of skid for the job.

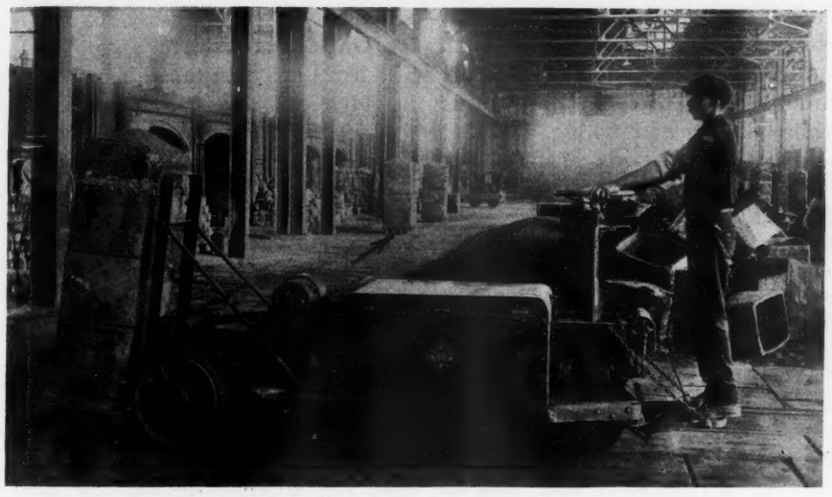
This truck has a special short platform so that it can get around sharp corners in the narrow aisles. It has a capacity of two tons and was built by the Automatic Transportation Company, Buffalo, N. Y. Separate trucks are used for day and night shifts, which gives ample opportunity for charging and overhauling. The 220-volt alternating current used in the plant is transformed for the charging panel by a vertical motor-generator set made by the Hertmer Electric & Manufacturing Company, Cleveland, Ohio.

## Repairs Speeded Up When a Crane Pulls the Pipe Wrench on Heavy Work

IN MANY plants an overhead crane is a necessary part of the equipment, even though it is idle the larger part of the time. At least, such is the case at the Chicago service shop of the Otis Elevator Company. Here two 5-ton Shepard cranes of 14 ft. span and 125-ft. runway are installed in two bays. The runways extend out over the truck entrance so that the crane can



**This crane does more than lift or carry as it takes the place of a gang of men by operating this chain pipe wrench.** Formerly eight to ten men spent about a day in screwing up and unscrewing this big repair job. Now the crane operates the wrench quickly and safely with only the machinist and his helper. The same method is used for coupling large pipes and also for screwing flanges on or off.



**One man can charge a 50-pot malleable furnace in two or three hours.** Ordinarily a gang of men would spend a day on this job. The charger is just as serviceable in removing the pots from the furnace and enables one company to take them out one day earlier than was formerly possible. The temperature is still above 200 deg., but the operator can stand it because he is 12 ft. back from the pot.

unload or load heavy material directly on or off the truck. These two bays are used for storage and erecting floors and are free of machinery except for a 36-in. lathe, a 10-ft. boring mill and a forcing press, which are used on large work. One crane handles heavy work to and from these machines as well as the assembly or disassembly of heavy work sent in for repair. This, however, does not keep the cranes busy so the superintendent uses them as shop tools in some repair work.

One big service job, for example, consists of refinishing the accumulator pistons of hydraulic elevator systems when the surface becomes corroded and causes leaks around the packing. These pistons are forged steel shafts about 21 ft. long and 12 in. in diameter. Usually they must be cut in two before they can be taken out of the basement of the building where they are installed. The first step in repairing them is to bore and thread a hole in the end of one piece and cut and thread a shoulder on the end of the other and screw them together. The outside is then turned down, the two parts unscrewed and sent to be installed.

Formerly all this screwing up and backing off was done by hand and as it required about eight men, took practically all the other men in the shop from their work for at least a day. Now the crane is brought over one end of the job and hooked up to the handle of a chain pipe wrench as shown in the illustration on the preceding page. Thus instead of a gang of men on the wrench, the machinist and his helper with the crane screw up and unscrew the shaft.

In the illustration the machinist has screwed it up only one or two threads to test the fit and is now backing it off. When he starts to screw it up finally another chain pipe wrench is placed on the other half and blocked, as it makes too great a strain on the clamps of the lathe chuck. With the crane pulling the wrench the job is speeded up, it is safer, and the other men are not taken from their work. The Shepard Electric Crane & Hoist Company, Montour Falls, N. Y., installed the cranes.

## Electric Charger Cuts in Half Cost of Charging Malleable Furnaces

A SPECIAL modification of the elevating platform industrial truck is used by a number of concerns for charging and emptying malleable iron furnaces. One of these in use at the Buffalo plant of Pratt & Letchworth Company is shown in the accompanying illustration. With this the pots, which contain small castings packed for annealing, are set up on supports or footings as shown by the arrow. Instead of a platform, as on regular elevating-platform trucks, two fingers or prongs project forward low enough to just clear the floor. These slip under a pot of castings and, through the elevating mechanism, raise the load 4½ in. in 10 seconds. As the load is raised it is tipped backward slightly so that it will not upset or tip over forward at any slight obstruction. The operator stands at the extreme end of the truck so that he is farthest from the heat when removing a pot from a warm furnace. In one plant the pots are removed while the furnace still registers over 200 deg. It takes only a second or two to run in, 10 seconds to raise the load, and a second or two to get out. The man is 12 ft. from the pot and as he is inside for only a moment, can stand the high temperature. When this job was done by men with hand trucks it was necessary to permit the furnace to cool at least a day longer before the pots could be handled. The truck deposits the pots on the cooling floor and after cooling takes them to the dumping floor.

Even when the truck is used for emptying hot furnaces, the rubber tires stand up well largely because they rest only momentarily on the hot furnace floor. Because of the ease of operation and ability to maneuver in close quarters, a truck can pick up or deposit a load in almost any reasonable position. Also it releases the overhead crane for other service and does not interfere with its operation. In addition, it does not interfere with the workmen nor require the attention of anyone except the operator. A charging truck will charge a 50-pot furnace in two or three hours while a gang of men would spend all day at it. The electric charging truck was made by The Elwell-Parker Electric Company, Cleveland, Ohio.

Comparative costs of the Elwell-Parker type LF charger and the air and steam charger which it displaced are given in the accompanying table:

### Costs With Electric Charger

| | | |
|---|---|---|
| Original cost of Type LF Charger with 30-cell battery | $4,100 | |
| Depreciation: $4,100 over 7.5 years | | $ 546.67 |
| Average yearly interest at 6% | | 136.73 |
| Maintenance: | | |
| Truck at 13.34% | | 426.67 |
| Battery 25% | | 225.00 |
| Charging 10,750 kw.-hr. at 1c per kw.-hr. | | 107.50 |
| Labor: One man at $5 (300 days) | | 1,500.00 |
| Total cost per annum | | 2,942.57 |
| Total cost per day | | 9.80 |

### Costs Under Previous Method

| | | |
|---|---|---|
| Original cost of older type charger displaced | $7,000 | |
| Depreciation: $7,000 over 5 years. | | $1,400.00 |
| Average yearly interest at 6% | | 252.00 |
| Maintenance 20% | | 1,400.00 |
| Extra time to steam up (unknown). | | |
| Labor: Two men at $5 (300 days) | | 3,000.00 |
| Total cost per annum | | 6,052.00 |
| Total cost per day | | 20.17 |
| Fuel or compressed air (unknown and not included but must be equal to electric current cost). | | |
| Net annual saving on investment for electric charger, over. | | $3,109.46 |
| Rate of saving on investment | | 75.8% |

# Coil-Making Methods

(*Continued from page* 342)

as at *d*. After the fourth turn, the wires are again pounded flat and the fifth, sixth and seventh turns are put on as shown in *e*, *f* and *g*.

In winding cross-over coils of square wire they should be reinforced at the cross-over by taping the wire with one half-overlapping layer of 0.004-in. by ¾-in. cotton tape. Round wire coils of No. 11 and larger should be similarly reinforced. In Fig. 9 is a close-up view of the end of a cross-over loop showing how the insulating tape is applied. At *h* (Fig. 6-C) is shown a cross-over coil three wires wide. In such a type the cross-over between layers—that is, the end of the third and the start of the fourth turns—should be taped.

In Fig. 3 are shown three finished puller coils. At *d* is a phase coil with a red tape around the lead end. The number of phase coils required per set equals the number of phases multiplied by the number of poles multiplied by two.

*P-C-B* and *P-C-H*—The puller types of coil for higher voltages *(P-C-B* and *P-C-H)* are made in the same manner as those described *(P-C-A)* except that more care is required. When there is a difference of potential between turns or layers of 20 volts or more, extra insulation should be provided. This insulation should extend completely around the coil. The following formulas show how to calculate the voltage between turns, layers, etc.:

*Formulas to Calculate Voltage Between Turns of Coils*

(Peak value of sin voltage wave.)

Volts per turn for single-phase, two-phase and three-phase delta = (line voltage) × (1.414) ÷ (turns per phase).

Volts per turn for three-phase star = (line voltage × 0.817) ÷ (turns per phase).

Turns per phase = (number of coils) × (turns per coil) × (number of circuits) ÷ (number of phases).

Number of circuits = one for series connection, two for two-parallel, three for three-parallel, etc.

On coils made with square wire the first turn around the pins should be reinforced with 0.007-in. tape half-lapped and every second turn after—that is, the first, third, etc., should be taped. This tape must extend around the pins and 1½ in. into the coil. This will prevent short circuits being made between turns while winding and pulling.

*Mold-Wound Coils (Mld)*—For certain types of coils it is necessary to wind on a mold. However, mold-wound coils should be used only when the end room in a motor prevents the use of a puller coil. Such coils are involute, half-diamond, half-involute and other special shapes. In Fig 5 are shown two molds very similar in shape. Two coils have been placed on the mold to the left to show how they fit. These molds are made of two blocks of wood and the working surfaces are reinforced with fiber. The base of the mold (at the left in each case) is attached to the winding machine. Then the other half is fitted on the base and it is held tight by means of a tapered key passing through the steel pin. The wire is wound in the slot formed when the two halves are put together. After the coil is wound, the outer block of the mold is removed so that the coil may be taken off. In order to hold the wires in place on the mold while winding, pivoted fiber wedges are placed as shown at the lower left-hand corner of the mold on the right.

Whenever it is possible, coils should be made on a shuttle and pulled to shape, because the mold coils are expensive to make; it takes a good carpenter from six to twenty-four hours to make the molds. Moreover, the winding itself is more expensive. For instance, if a coil is 2x6, two single coils will have to be wound and then assembled to make a complete unit. If the wires are to be in series, two single coils have to be wound and then assembled and the wires connected together with a copper sleeve and soldered. If the coils were made on the puller, they could be wound cross-over, thus doing away with soldering a joint and winding one coil.

Mold-wound coils are stiffened in the same way as puller coils. For instance, they are stiffened by fullerboard strips as at *A* in Fig. 7, or by wrappers of "Bearon" paper as shown at *F* of Fig. 7.

*Strap-Copper Coils (Ren-A, -B* and *C)*—Strap-copper coils are bent into loops and formed to shape by a hammer on a mold. Some strap-copper coils may be pulled in the same manner as other coils. When a special job is encountered, insulating data should be developed. Fig. 9 (left) illustrates a four-turn stator coil. The leads are both taped about 6 in. into the coil and the ends of the first and third turns are taped as shown. The mica wrapper shown in the center is interwoven between the straps before tape is applied to the entire coil. Fig. 9 (right) shows a three-strap coil from a wave-wound 550-volt railway armature. The leads should be smooth and free from pin points and should be tinned. The coil is shown with the assembling tape applied after the middle strap has been taped through the slot section as shown at *e*. This is done to keep the center of the slot the same size as the corners, where the end taping is around all three straps. Methods of placing mica and fish-paper insulation between turns of strap-copper coils and between coil sides are shown in Fig. 6-*D*.

*Soldering Leads*—For alternating current the leads of all coils should be scraped and tinned. In fact, it is advisable to have cheaper labor tin and scrape the leads on all coils.

# Intra-Plant Transportation

(*Continued from page* 329)

charging boards of the sectional variety may be obtained which can be expanded as needs indicate.

In providing charging service for seventeen trucks a single motor-generator was installed of 400-amp. capacity and 75-volt to 85-volt operating range, and a standard type of sectional 110-volt charging panel was used. An additional resistor was supplied for each panel designed for 110 volts drop at the rated charging amperage for use with the 220-volt shop circuit when the generator is down for repairs or when a single truck is to be charged during the day. Double-throw drum controller switches were built in the electrical shop and one switch was installed for each unit of six panels for quickly changing the panel connections from the charging generator to the shop circuit. As more trucks are added a duplicate motor-generator may be installed and sectional charging panels added.

The charging circuits should be placed underground between the charging panels and central distribution point, with a conduit run on the garage (*Continued on page* 362)

# Trade Literature
## *you should know about*

**General Lead Batteries Company,** Chapel Street and Lister Avenue, Newark, N. J.—Bulletin No. 34, entitled "Manifestations of Proper and Improper Battery Operation," contains 12 interesting and instructive pages on the history, care, use, and abuse of storage batteries.

**Westinghouse Electric & Manufacturing Company,** East Pittsburgh, Pa.—Circular 1579-B describes "Micarta" for gears and pinions—a non-metallic material for silent gear drives. This is a laminated product of specially treated woven fabric made up in sheets, blanked out and machined down. General and technical information for cutting and designing gears of this material is included.

**Federal Electric Company,** 8700 South State Street, Chicago, Ill.—Circulars describing the Federal "Three-Thirty" renewable fuse plug which it is claimed takes care of the excessive current due to starting torque and small line surges, and thus makes it unnecessary to use a plug several times larger than required for normal loads in order to take care of momentary heavy currents. While the plug is a renewable plug, only the cartridge element furnished by the manufacturer can be used and so is "foolproof."

**P. E. Chapman Electrical Works,** 10th and Walnut Street, St. Louis, Mo.—Bulletin No. 110 describes the Chapman Armeter for making tests of small armatures in production work, particularly where large numbers of armatures of the same size are to be tested.

**Nathan Klein and Company,** 208 Centre Street, New York City—Catalog R lists a large variety of new standard made industrial supplies, such as motors, hoists, transmission equipment, welding outfits, fans, electric drills, and numerous other pieces of equipment.

**The Truscon Laboratories,** Detroit, Mich.—The "Architects Specification Handbook," recently issued, gives specifications for the use of the waterproofings, dampproofings, oil proofings, concrete floor hardeners, protective steel coatings and finishing varnishes manufactured by this company. Anyone interested may receive special literature describing each product, its uses and application.

**The Electrical Alloy Company,** Morristown, N. J.—A 12-page bulletin entitled "Electrical Heating Reference Data" contains numerous charts showing the current-carrying capacity of resistance ribbon and strap, together with suggestions for the designing of heating elements.

**Cowan Truck Company,** 7 Water Street, Holyoke, Mass.—Bulletin No. 5 describes the mechanism, operation and utility of the Cowan electric self-loading truck for handling loads on skids or platforms.

**Autovent Fan & Blower Company,** 730 West Monroe Street, Chicago, Ill.—The tenth edition of the catalog of "Modern Ventilating Apparatus," recently issued in loose-leaf form by this company, contains a large amount of heating and ventilation data. Performance tables are included for each type and size of propeller fan and blower supplied by this company.

**Johnson Gas Appliance Company,** Cedar Rapids, Iowa—Circulars describe a medium-size gas furnace for melting soft metals. The capacity is 150 lbs. of metal. The burners will develop any desired temperature up to 2,250 deg. F.

**Allis-Chalmers Manufacturing Company,** Milwaukee, Wis.—Bulletin No. 1099 B describes the types AB and AH belted, alternating-current generators. Details of the construction of the bearings, windings, collector rings and brushes, and electrical characteristics are included.

**P. E. Chapman Electrical Works,** St. Louis, Mo.—Bulletin No. 101 describes a new motor-driven taping machine equipment for armature and field coils. Through belt drive and a cone clutch which is mounted on a slow-speed motor, very rapid and close adjustments of speed are obtained by pressure on the foot treadle. The machine may be equipped with various types of taping heads and will find a ready place in industrial and commercial repair shops as well as in many plants making electrical equipment.

**Link-Belt Company,** Chicago, Ill.—Book No. 125 on Link-Belt silent chain for the efficient transmission of power contains, in addition to numerous illustrations of drives in various industries, a large amount of data on design and selection of drives, and reference tables on the horsepower transmitted by various types of transmission.

**Allis-Chalmers Manufacturing Company,** Milwaukee, Wis.—Bulletin No. 1109 describes the Allis-Chalmers line of oil-immersed, self-cooled, outdoor type distribution transformers suitable for lighting or power purpurposes. Transformers having ratings of 200 kva. and smaller are known as distribution transformers.

**R. W. Cramer & Co.,** 136 Liberty Street, New York City—A recent loose-leaf booklet describes the Souter time switches and their application.

**Young Brothers Company,** Detroit, Mich.—A booklet on "Industrial Ovens" illustrates and describes a number of installations of compartment and continuous conveyor ovens. Considerable space is devoted to the construction of the oven, its ventilation and circulation, insulation, heating, and special auxiliary handling equipment.

**Cooper-Hewitt Electric Company,** 95 River Street, Hoboken, N. J.—A series of briefs containing reprints or digests of articles on industrial lighting are distributed to anyone interested who asks to be put on the mailing list. Two recent briefs are entitled "What Is Meant by 'Reaction Time'?" and "Industrial Lighting in Theory and Practice."

**The Safety Equipment Service Company,** East Eleventh Street and Hamilton Avenue, Cleveland, Ohio—Catalog D of this company, which is the successor of the safety department of The Strong, Kennard & Knutt Company, lists safeguards, safety signs, welding lens, goggles and numerous other safety appliances.

**Borne Scrymser Company,** 80 Soutb Street, New York City—A recent folder illustrates a number of turbine installations which use "Turboil," a special turbine lubricant.

**The Griscom-Russell Company,** 90 West Street, New York City—Bulletin No. 904 describes the "Multiwhirl" cooler. Some of the applications are: Cooling of lubricating, quenching or transformer oil, recovery of heat from waste liquors, condensing or subcooling of gasoline and solvent vapors and in the exchange of heat between two liquids. The liquid to be cooled passes through a helical baffle and so has a smooth flow with a minimum of friction.

**Becker Brothers, Inc.,** 23-25 North Jefferson Street, Chicago, Ill.—Catalog No. 6 gives data and characteristics on the various groups of motor brushes handled and the particular type of service to which each is adapted.

**Duncan Electric Manufacturing Company,** Lafayette, Ind.—Bulletin No. 104 describes the Duncan switchboard watthour meters for direct-current service. Construction features and wiring diagrams are included.

**Sangamo Electric Company,** Springfield, Ill.—Bulletin No. 57 describes the Sangamo type of amperehour switchboard meters for single-phase and polyphase alternating current and two- and three-wire direct current, including connection diagrams and installation instructions.

**Square D Company,** Detroit, Mich.—A small circular anounces the new 76,000 line of switches with a single-throw action.

**Westinghouse Electric and Manufacturing Company,** East Pittsburgh, Pa.—Leaflet No. 1134 describes in considerable detail electrical equipment for pumping oil wells. Some of the important advantages of electric pump-

ing are: Continuity of service, relatively low cost of electric power, absence of stand-by losses, the efficiency of an electric motor, close speed adjustment to give maximum production, greater speed at which cleaning and pulling can be done, and lower maintenance and attendance cost.

**The Aetna Abrasive Company,** 463 West Ohio Street, Chicago, Ill.—A small folder describes the Aetna improved commutator smoothing stones and gives the grades to be used for specific purposes. Price lists and dimensions of the several types are included.

**Westinghouse Electric and Manufacturing Company,** East Pittsburgh, Pa.—Leaflet No. 3429 describes and illustrates the advantages derived from arc splitters in conjunction with the magnetic blow-outs of contactors.

**Allis-Chalmers Manufacturing Company,** Milwaukee, Wis.—Bulletin No. 1124, entitled "Synchronous Motors," describes and illustrates the various motors of this type put out by this company, their construction and application. Two pages are given over to an explanation, illustrated by charts, of the use of a synchronous motor for improvement of the power factor.

**Mechanical Appliance Company,** Milwaukee, Wis.—Recent literature announces a new line of Watson a. c. multi-speed motors brought out by this company, which provide for speeds of 600, 720, 900 and 1200 r.p.m., a range of speed heretofore available only on d. c. motors, it is claimed. Until recently the standard 4-speed windings on a. c. motors were 600, 900, 1200 and 1800 r.p.m. on 60-cycle circuits, the two higher speeds are twice the two lower speeds. With the interjection of the 720 r.p.m. speed, a narrower range of speed increment is possible. This is obtained by using an independent winding on the stator for each speed. Either automatic or remote control, equipped with the suitable protective devices, may be used.

**The Brown Instrument Company,** Philadelphia, Pa.—A recent catalog explains the theory of "Resistance Thermometry," the various types of instruments which are made, the merits of each type, and the field which this instrument covers. It operates upon the basis of electrical resistance, rather than pressure, is claimed to have greater accuracy, extremely rapid speed of action, and is especially adapted where extreme accuracy is required within a small range of temperature. The Brown Instrument Company will send this catalog to any executive requesting it on the letterhead of his company.

**The A. C. White Company,** 15 Hermon Street, Worcester, Mass.—A recent folder describes the use of White adjustable portable floor light stands with a plug outlet for connecting in shop tools.

# Intra-Plant Transportation

(*Continued from page* 360)

walls with junction boxes and receptacles spaced according to the requirements of the trucks.

### Methods of Arriving at Costs

Although the economic necessity of industrial electric transportation requires no brief, yet in any industrial practice which may either progress or deteriorate, some means should be provided to ascertain the efficiency of the practice in some unit of measure. This requirement is best met in the operation of industrial trucks by computing the cost of hauling a certain tonnage a certain number of miles—called "ton-miles" or else simply the cost of operating a truck for one day—based on the monthly cost data. This data may be prepared by the electrical department or by the plant cost-accounting department, depending on the company policy. Where materials of similar nature are handled continuously, a weight test may be made at intervals and a fairly accurate estimate made of the tonnage between tests while a continuous tally of the trips over a measured course should be kept to determine the mileage.

This data is not so easily obtained when trucks are largely used for transporting machinery repair parts and construction material and for miscellaneous duties in production departments. Under these conditions considerable effort is necessary to obtain the weights of materials handled during the test which usually covers a month. Where the number of trucks is small, each driver may be given a small notebook and required to note each item handled and the building numbers where the material was picked up and where delivered. Wherever possible the driver weighs his load on an automatic floor scale and in other cases estimates it.

In one instance where a large number of trucks are used a "Truck Driver's Report" card was employed for showing the daily delivery of material made by each truck or tractor. The report (reproduced on page 326) shows the material handled, the time delivered and point of origin and delivery. A plant map may be scaled for distances between buildings and a table prepared giving distances over regular truck routes between any two points. The note books should be checked up every morning during the test, the driver taking another notebook while one is being added and recorded by the electrical department office. The tonnage and distance for each truck is recorded daily during the test.

### Repairs Should Be Charged to Each Truck

The records of maintenance of the individual truck, as well as the average cost per truck, is of interest to the plant engineer. This is desirable because trucks of different capacities, power and make may be employed in one plant in which case a comparison would be futile without repair costs of individual trucks. Without demanding an excess of clerical effort an effective method of obtaining repair costs is to retain a triplicate copy of each storeroom requisition for repair parts. The material may be charged to the general truck account with a sub-number added to designate the individual truck, such as Job No. 301-12. Where sub-numbers are otherwise employed in accounting, the words "Truck No. 100" may be added. At the end of the month these requisition copies should be priced and totaled and entered in a record book. The time of the truck attendant should be distributed according to the trucks worked upon. This may be kept on a time card by the individual or by the department time-keeping system. In this way a simple and accurate table of operating costs is available; to it the fixed charges may be added.

# Equipment Changes and Maintenance

(*Continued from page* 324)

installed and correctly loaded. Operators are urged to report at once any symptoms of trouble. When a motor is put into service the speed is determined, and volt- and ammeter readings are taken, as mentioned previously, to make sure that it is correctly loaded. These readings are taken again whenever the motor is relocated or its load changed. Finally, every motor is thoroughly overhauled twice a year, in July and December. At these times the coils are painted, the bearings replaced if necessary and any other repairs made which are needed to put the motor in first-class condition.